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NOTES ON GEOGRAPHIC DISTRIBUTION

New photographic records of eight marine fishes from the Galápagos Islands, including three first records for the Eastern Tropical Pacific

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Abstract. We provide photographic evidence for eight fish species from five families, not previously seen within the Galápagos Marine Reserve. Four species are native to the Central Tropical Pacific and likely arrived during recent El Niño phenomena: *Acanthurus leucocheilus* Herre, 1927, *Acanthurus olivaceus* Bloch & Schneider, 1801, *Naso hexacanthus* (Bleeker, 1855), and *Chaetodon punctatofasciatus* Cuvier, 1831. One is a pantropical species: *Kyphosus sectatrix* (Linnaeus, 1758). The remaining species likely originated within the Eastern Tropical Pacific: *Ctenochaetus marginatus* (Valenciennes, 1835), *Halichoeres malpelo* Allen & Robertson, 1992, and *Gymnothorax porphyreus* (Guichenot, 1848).

Key words. Eastern Pacific Barrier, ENSO, marine reserve, rafting, reef-fish, vagrant

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INTRODUCTION

The Galápagos Islands lie on the southwestern edge of the Eastern Tropical Pacific (ETP), a region that extends latitudinally from the Gulf of California to northern Peru, nestled between the subtropical gyres of the North and South Pacific (Kessler 2006). The Galápagos are geographically isolated from the Central Tropical Pacific (CTP) islands, with the nearest being Kiritimati of the Line Islands 7300 km away. The East Pacific Barrier (EPB), a major oceanographic divide, limits larval transport and genetic connectivity between marine species in the ETP and CTP (Grigg and Hey 1992; Lessios and Robertson 2006). Despite this barrier, species from the CTP occasionally reach the ETP, particularly those from the order Acanthuriformes. Prior to 2024, seven Acanthuridae and five Chaetodontidae species had been recorded as vagrants in the region (Robertson and Allen 2024). These sightings were mostly restricted to the warmer waters of the northern Galápagos Islands, which have greater connectivity with the North Equatorial Countercurrent (NECC) (Edgar et al. 2004; Kessler 2006; Sweet et al. 2007).

Over the course of 2024, coinciding with the end of the 2023–2024 El Niño event (NOAA 2024), the Charles Darwin Research Station's Subtidal Ecological Monitoring (SEM) team, along with other divers, recorded several tropical fish species not previously documented in the Galápagos Marine Reserve (GMR) or the ETP. These observations were primarily concentrated in the Northern and Far Northern bioregions (Edgar et al. 2004) (Figure 1). Additionally, three native ETP species were observed for the first time in the GMR.

The sites at which each species was seen are diverse in terms of topography and ocean conditions. The islands of Darwin and Wolf are situated within the Far North bioregion of the GMR. Darwin's Arch is a platform with a steep drop-off, attracting pelagic species that arrive for cleaning. Wellington Reef, also located at Darwin Island, is a kilometre-long, gently sloping structural coral reef with depths ranging between 10 and 25 m (Glynn et al. 2015). The site is often exposed to strong currents and localised upwelling, which helps to maintain reef health during severe ENSO events (Riegl et al. 2019). In contrast, Wolf's Coral Garden is a sheltered bay on the eastern side of the island, featuring a sloping, non-structural reef from 5 to 30 metres that leads to a sandy plain. This reef also experiences some localised upwelling and hosts highly diverse coral communities, with colonies reaching several metres in height. On the west of the island is Anchorage Bay, which has a similar slope but significantly lower coral cover.

Located in the Northern bioregion, Pinta's east coast site had relatively high coral cover during a February visit, but by May, much of it had died and been overtaken by filamentous algae, likely due to temperature

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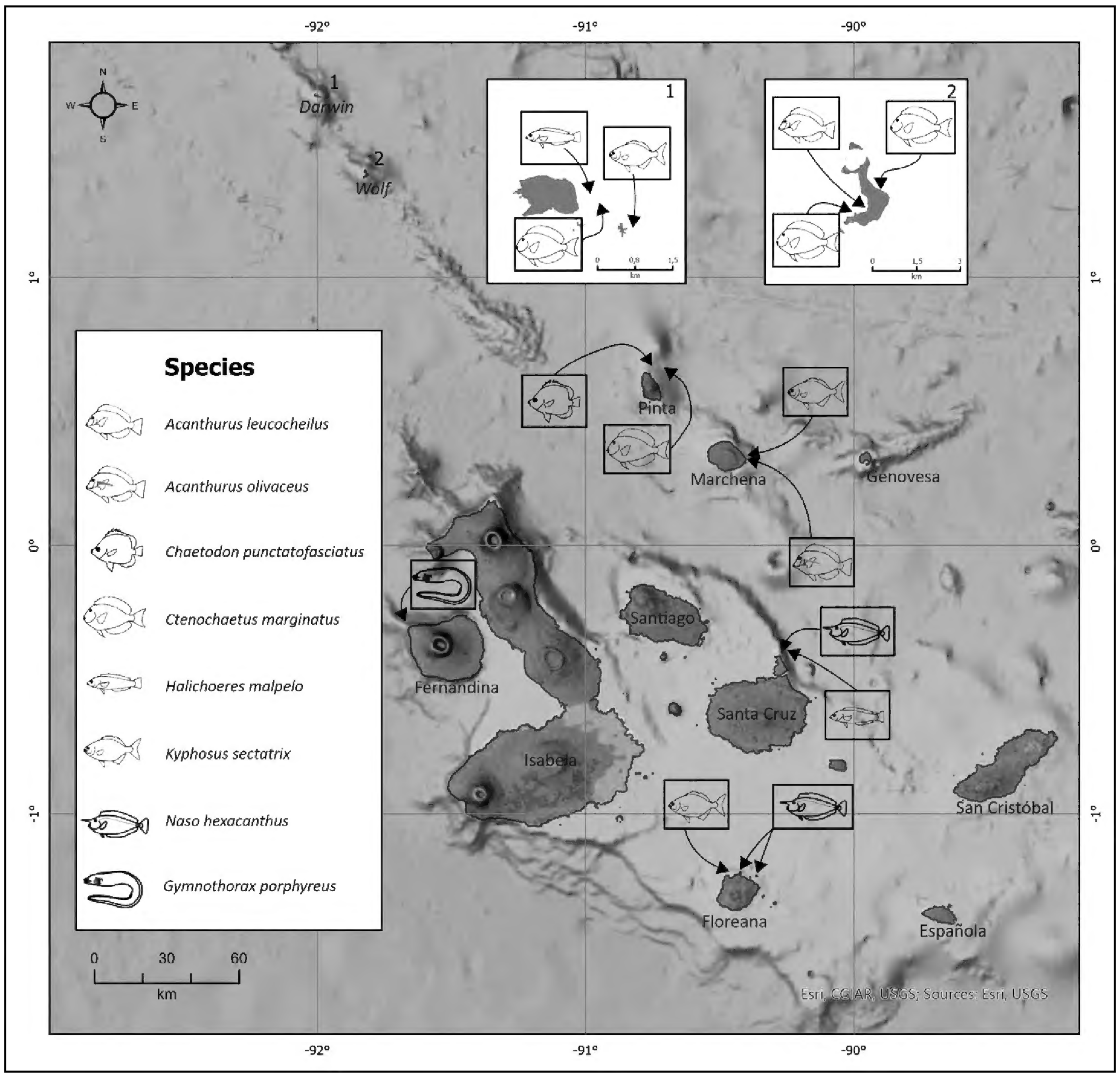

Figure 1. Map of the Galápagos Archipelago showing the locations at which each species was found. The islands of Darwin and Wolf are enhanced in frames 1 and 2 respectively. Map created by Johny Mazón (CDF). Species outlines provided by www.stri.org/sftep.

shock. Marchena's Islote Espejo, adjacent to Roca Espejo, features an extensive rock and coral reef with medium to high current exposure, sometimes making the site undiveable.

Seymour North's Fishbowl, located in the Central bioregion, is a sandy plain bordered by a rocky reef where schools of fishes gather for cleaning. Nearby, Mosquera is characterised by a sandy plain, with a wall dropping down on one side and a rocky slope rising on the other.

Floreana Island, located in the southern part of the archipelago but still belonging to the Central bioregion, is heavily influenced by the Humboldt Current. Surrounding the island are several islets and rocky outcrops where the species were encountered. Champion features a steep wall on one side and a rocky slope on the other. Corona del Diablo, a relatively shallow site (~12 metres), is exposed to strong currents and hosts a rock and coral reef. Enderby has a sheltered, collapsed crater and a sloping outer rocky structure.

Among the discoveries were four surgeonfish (Acanthuriformes, Acanthuridae) species newly recorded in the GMR, two of which were previously undocumented in the ETP. Although this circumtropical family is diverse and primarily associated with coral reefs, species richness in the ETP is comparatively low, with just five resident species across three genera (Sale 1991; Nelson et al. 2016; Fricke et al. 2025; Robertson and Allen 2024). The records include *Ctenochaetus marginatus* (Valenciennes, 1835), *Acanthurus leucocheilus* Herre, 1927, *Acanthurus olivaceus* Bloch & Schneider, 1801, and *Naso hexacanthus* (Bleeker, 1855). *Chaetodon punctatofasciatus* Cuvier, 1831 (Chaetodontidae) was also newly recorded in the GMR and is part of a speceis complex known to hybridise (Montanari 2018).

Additional records include the pantropical chub *Kyphosus sectatrix* (Linnaeus, 1758) (Centrarchiformes, Kyphosidae), whose juveniles are known to disperse via rafting on marine debris (Jokiel 1990; Knudsen and Clements 2013, 2016; Gilbert 2015). The moray eel *Gymnothorax porphyreus* (Guichenot, 1848) (Anguilliformes, Muraenidae) was also recorded for the first time in the GMR. Its long-lived leptocephalus larvae are capable swimmers, likely enabling their dispersal across large distances via ocean currents (Miller 2009). Finally, *Halichoeres malpelo* Allen & Robertson, 1992 (Labriformes, Labridae a member of the *H. melanotis* species complex and one of the oldest *Halichoeres* lineages in the ETP) was recorded for the first time in the Galápagos (Wainwright et al. 2018; Victor et al. 2024)

METHODS

All species observations, except for *Halichoeres malpelo* at North Seymour; *Ctenochaetus marginatus* at Pinta East; *Naso hexacanthus* at Corona del Diablo, Mosquera, and Enderby; and *Gymnothorax porphyreus* at Cabo Douglas, were recorded during dives associated with the Subtidal Ecological Monitoring project. The surveys in which the species were observed took place in October 2021, April 2023, and January, February, and May 2024. Species not recorded during the monitoring effort were instead observed through a combination of scientific and recreational dives.

All new observations presented in this publication, bar *N. hexacanthus* by F. Rivera in 2001, are supported by photographic evidence. The exception was documented through a visual census by a trusted scientific observer, who was consulted and confirmed the observation. The visual census observation is listed as "New survey record" within the results section.

The annual monitoring effort, conducted by researchers of the Charles Darwin Research Station in collaboration with Galápagos National Park rangers, aims to track trends in rocky and coral subtidal communities within the Galápagos Marine Reserve. Monitoring is conducted across at least 63 diagnostic sites, covering all bioregions of the archipelago and the various marine usage zones established during the GMR's zonification in 2000 (Heylings et al. 2002). The methodology, outlined by Banks et al. (2016), involves three divers, each responsible for monitoring a different group via a non-invasive visual census. The three main groups observed are sessile organisms, mobile macroinvertebrates (with molluscs under 2 cm monitored separately), and fish. Under the current standardised method, the monitoring has run continuously since 2004, but records stretch back to 1994.

The fish group primarily focuses on demersal species but also includes cryptic and pelagic fish, as well as any marine reptiles, birds, or pinnipeds that enter the transect. Transects of 50 metres are placed at both 15 and 6 m for every site, topography permitting, with the observation area defined by 1250 m^3 tunnels on each side of the transect (Banks 2016: fig. 6–1). Data on taxonomy, abundance and size are recorded for each observation.

The location data for previous range was taken from OBIS (2025) and GBIF.org (2025). Any outlier locations were checked and removed if believed not to be of a reliable source. Any records from iNaturalist observations on GBIF were first verified visually to ensure the correct species ID. Outlier records from Reef Life Survey were discarded.

RESULTS

Ctenochaetus marginatus (Valenciennes, 1835)

Figures 2, 3

New photographic records. ECUADOR — Galápagos • Wolf, Anchorage Bay; 01.379°N, 091.819°W; 15 m depth; 06.II.2024; W. Bensted-Smith obs.; 1 individual photographed • Wolf, Coral Garden; 01.387°N, 091.817°W; 15 m depth; 07.II.2024; W. Bensted-Smith obs.; 2 individuals photographed • Pinta, East Pinta; 00.626°N, 090.755°W; 15 m depth; 06.V.2024; C. Estapé and A. Morgan-Estapé obs.; 1 individual photographed • Wolf, Coral Garden; 01.387°N, 091.817°W; 15 m depth; 19.V.2024; W. Bensted-Smith obs.; 2 individuals photographed • Wolf, Coral Garden; 01.387°N, 091.817°W; 15 m depth; 20.V.2024; W. Bensted-Smith obs.; 3 individuals photographed • Darwin, Wellington Reef; 01.678°N, 091.997°W; 15 m depth; 21.V.2024; W. Bensted-Smith obs.; 1 individual photographed • Darwin, Wellington Reef; 01.678°N, 091.997°W; 15 m depth; 22.V.2024; W. Bensted-Smith obs.; 1 individual photographed.

Identification. *Ctenochaetus marginatus* is a medium-sized surgeonfish that can reach a total length (TL) of 30 cm. It primarily inhabits shallow waters but has been observed at depths of up to 40 m (Randall and Clements 2001; Robertson and Allen 2024). This species can be mistaken for *C. binotatus* Randall, 1955 due to their overlapping geographical ranges and similar appearance. Both species have dark brown bodies with small pale-blue spots on the head and anterior body, which transition into longitudinal rows on the posterior body. However, *C. marginatus* sometimes has spots covering its entire body (Figure 4B, D).

The most reliable differentiating marker between these species is the presence of two prominent black spots at the rear base of the dorsal and anal fins of *C. binotatus*, which extend onto the adjacent body (Figure 4A, B) (Randall and Clements 2001; Robertson and Allen 2024).

There is a limited amount of photographic evidence of juvenile *C. marginatus* (iNaturalist 2024; Robertson and Allen 2024), which make it hard to compare the observations against. However, the absence of dark spots at the posterior base of the anal and dorsal fins of the Galápagos juveniles (Figure 2) was a determining factor (G. Allen, R. Robertson, and B. Victor pers. comm. 2024).

Distribution. *Ctenochaetus marginatus* is typically found in the CTP and offshore ETP islands, with occasional records along the Pacific coasts of the Philippines and Central America to northern South America (Figure 3) (Robertson and Allen 2024; Fricke et al. 2025; GBIF.org 2025; OBIS 2025).

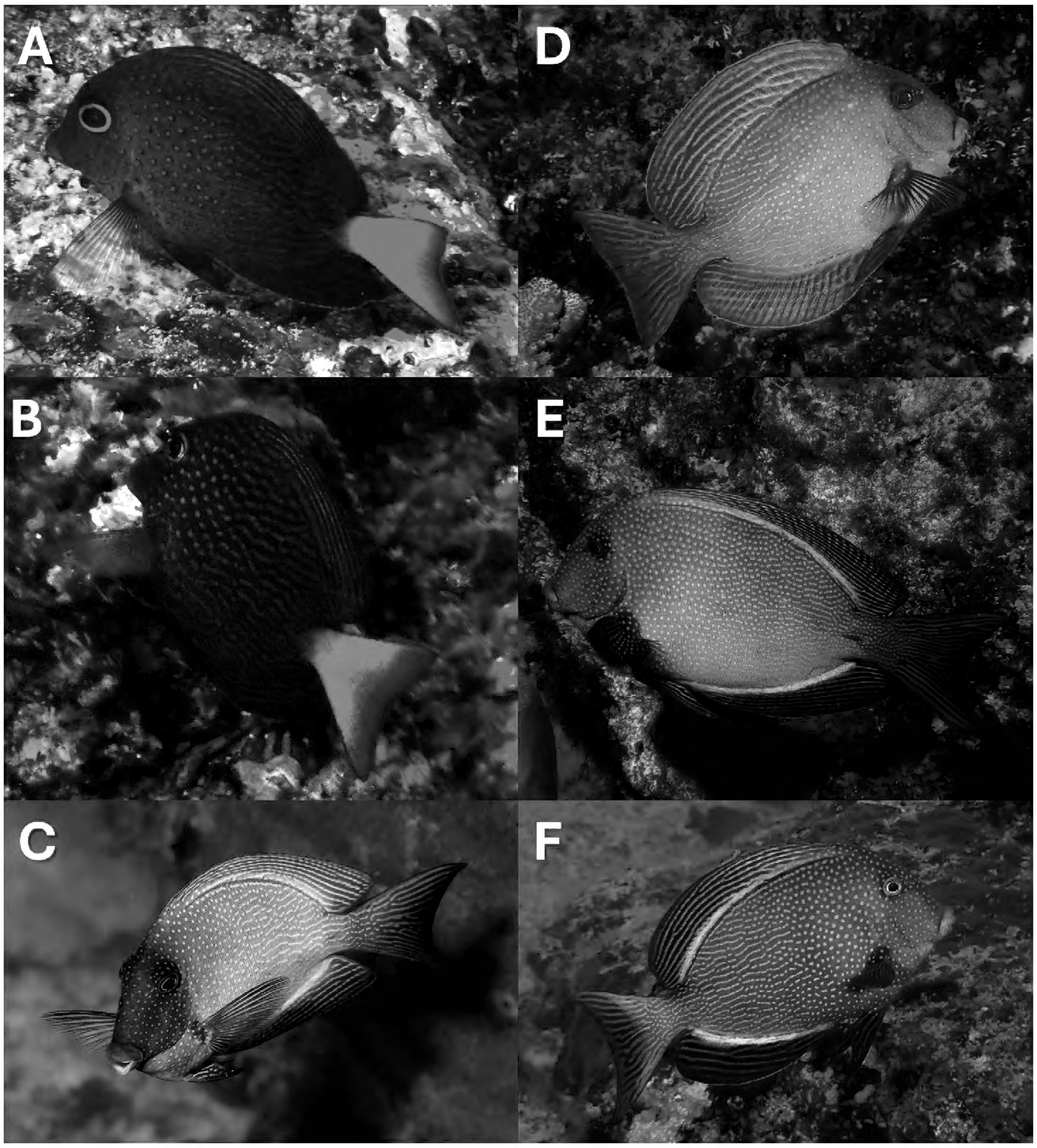

Figure 2. *Ctenochaetus marginatus*. **A.** Juvenile at Wolf's Anchorage Bay on 2024-2-6, photo by W. Bensted-Smith. **B.** Juvenile at Wolf's Coral Garden on 2024-2-7, photo by W. Bensted-Smith. **C.** Subadult at Pinta East on 2024-5-6, photo by C. and A. Estapé. **D.** Subadult at Wolf's Coral Garden on 2024-5-19, photo by W. Bensted-Smith. **E.** Adult at Wolf's Coral Garden on 2024-5-20, photo by W. Bensted-Smith. **F.** Subadult at Darwin's Wellington Reef on 2024-5-21, photo by W. Bensted-Smith.

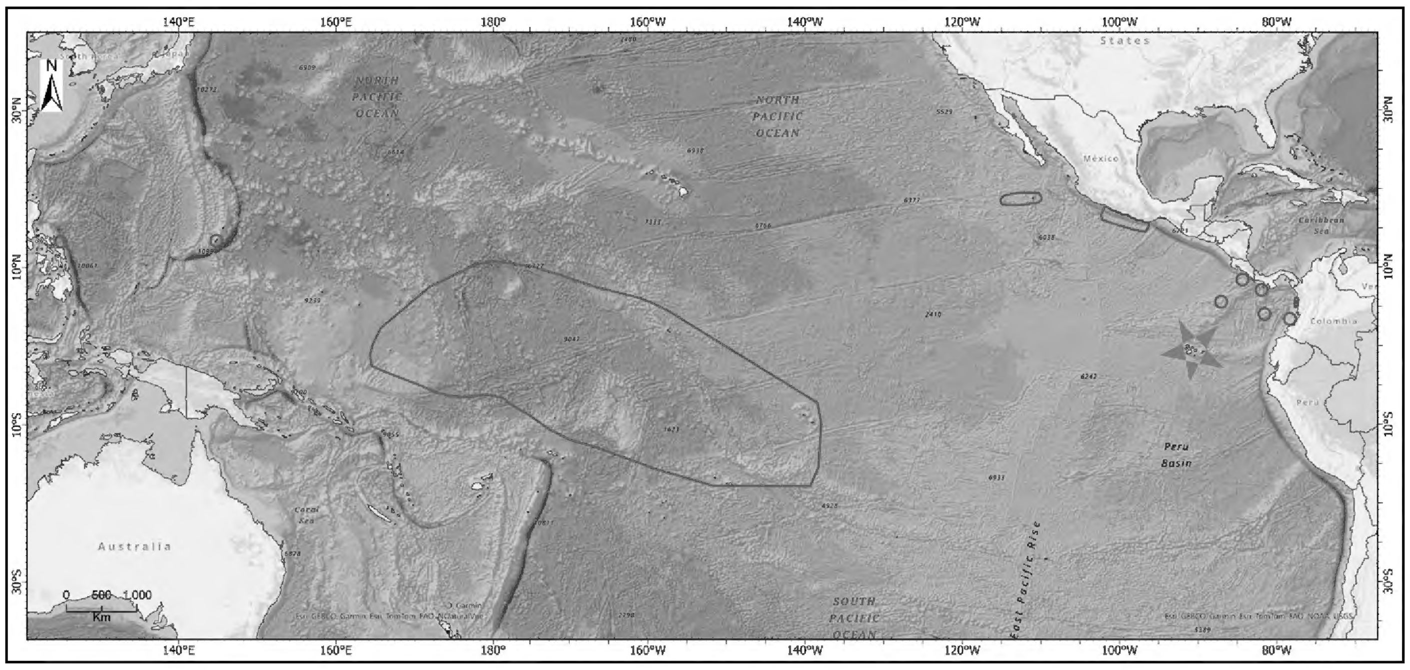

Figure 3. Previous recorded distribution (red) of *Ctenochaetus marginatus* and the new photographic records (yellow star). Map created by Johny Mazón (CDF).

Acanthurus leucocheilus Herre, 1927

Figures 5, 6

New photographic record. ECUADOR — Galápagos • Wolf, Anchorage Bay; 01.380°N, 091.818°W; 15 m depth; 07.II.2024; W. Bensted-Smith obs.; 2 individuals photographed.

Identification. *Acanthurus leucocheilus* is a large surgeonfish, known to reach a standard length of 45 cm. It inhabits shallow, protected reef flats and slopes reefs, at depths of up to 40 m. In Pacific populations, the species has a white vertical band at the base of the caudal fin, which appears to be absent in some Indian Ocean populations (Kuiter and Tonozuka 2001; Allen and Erdmann 2012).

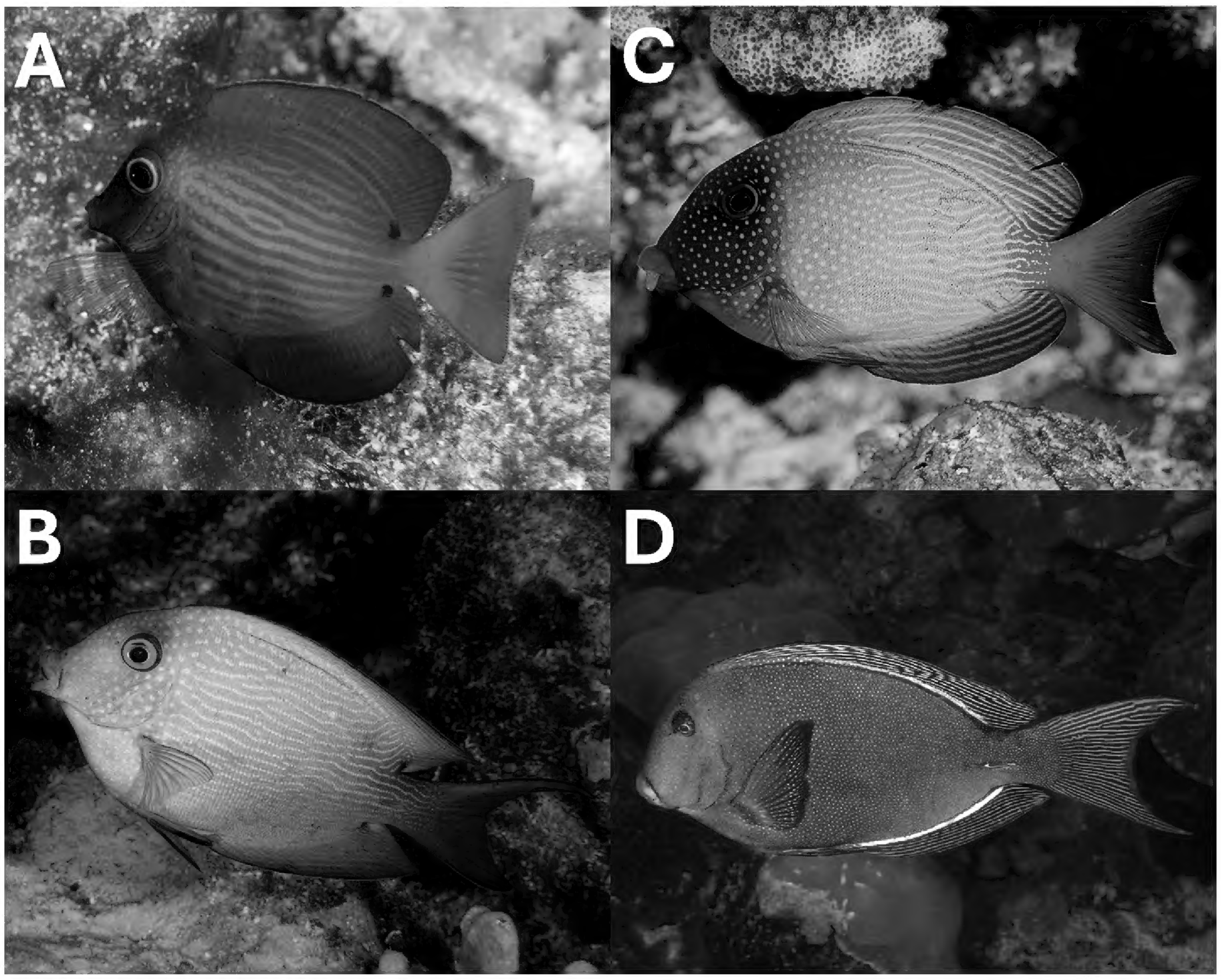

Figure 4. A, B. *Ctenochaetus binotatus*. **A.** Juvenile side-view, photo by M. Rosenstein at Ra, Fiji. **B.** Adult side-view, photo by P. Osborn at Raja Ampat, Indonesia. **C, D.** *Ctenochaetus marginatus*. **C.** Juvenile side-view, photo by D. Rolla at Kiritimati, Kiribati. **D.** Adult side-view, photo by W. Bensted-Smith at Isla del Coco, Costa Rica.

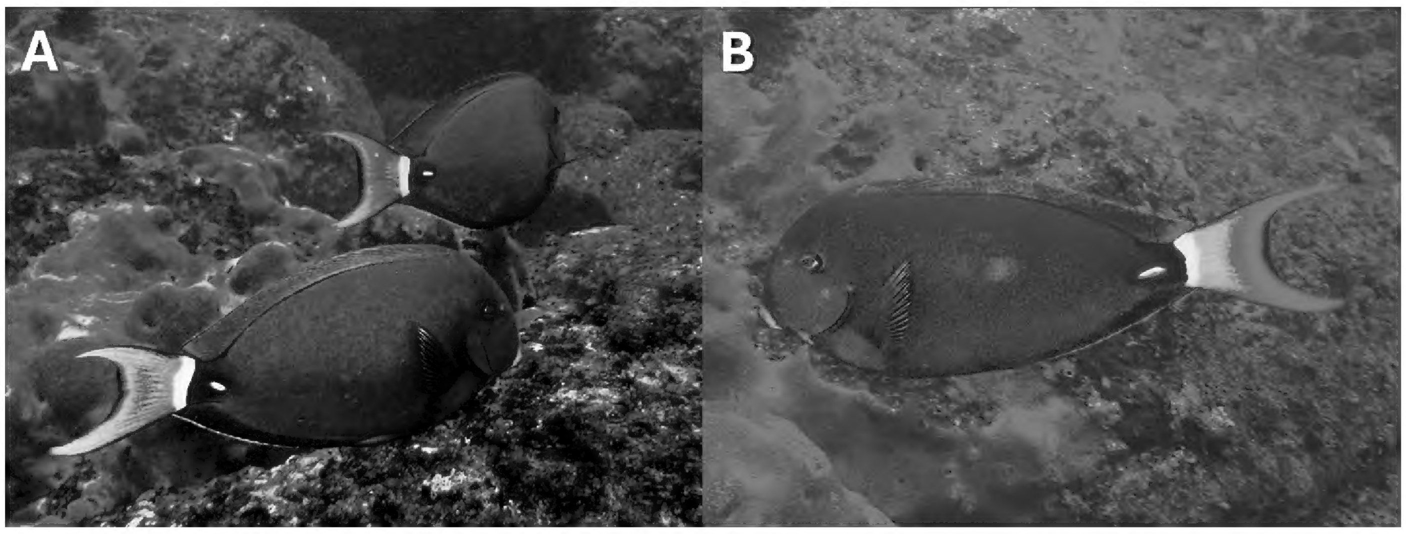

Figure 5. A, B. *Acanthurus leucocheilus* at Wolf's Anchorage Bay on 2024-2-7, photos by W. Bensted-Smith.

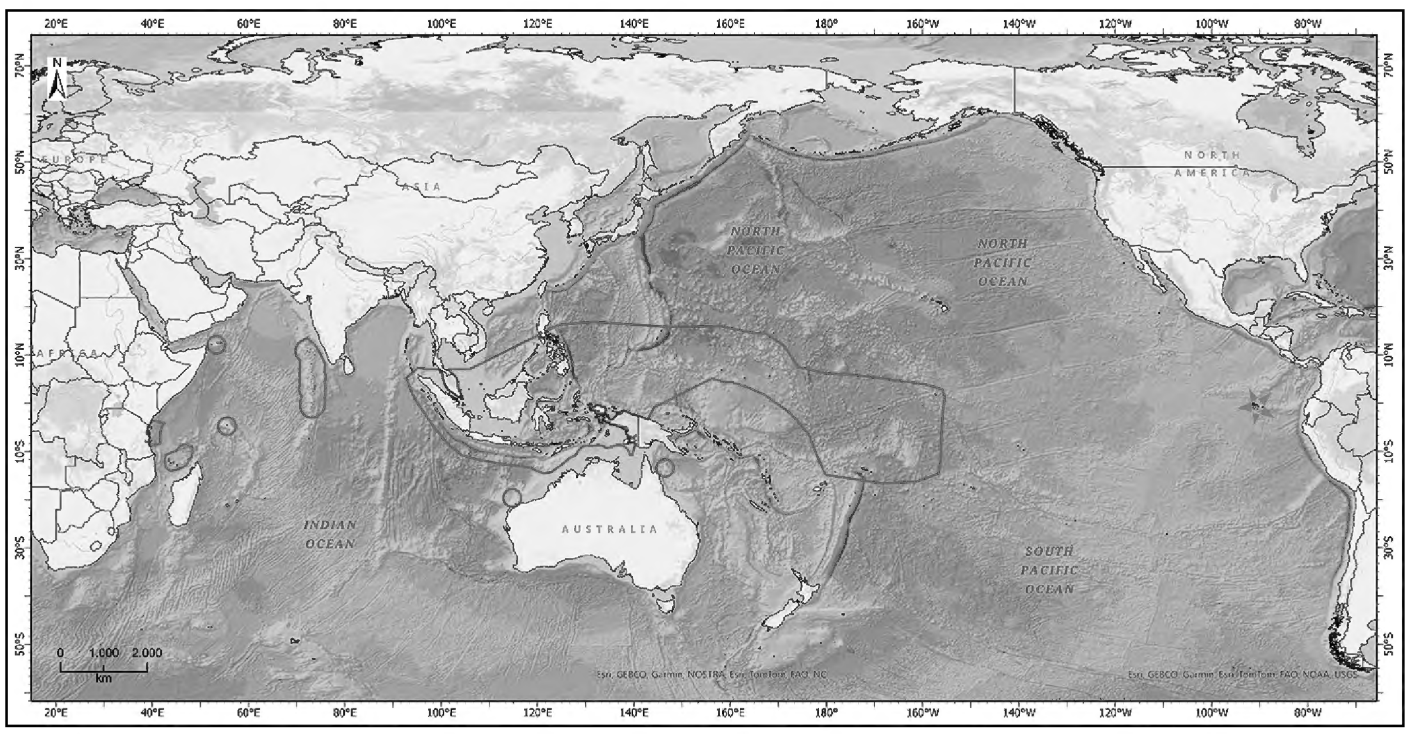

Figure 6. Previous recorded distribution (red) of *Acanthurus leucocheilus* and the new photographic records (yellow star). Map created by Johny Mazón (CDF).

Underwater, *A. leucocheilus* (Figure 7A, B) could be confused with *A. nigricauda* Duncker & Mohr, 1929 (Figure 7C). Both fish share similar lunate caudal fins with a white band at the base, a bright-yellow bar on the posterior third of the pectoral fin, and a narrow blue margin on the dorsal and anal fins. However, they can be differentiated by several key features. *Acanthurus nigricauda* has a black bar behind its eye, while *A.*

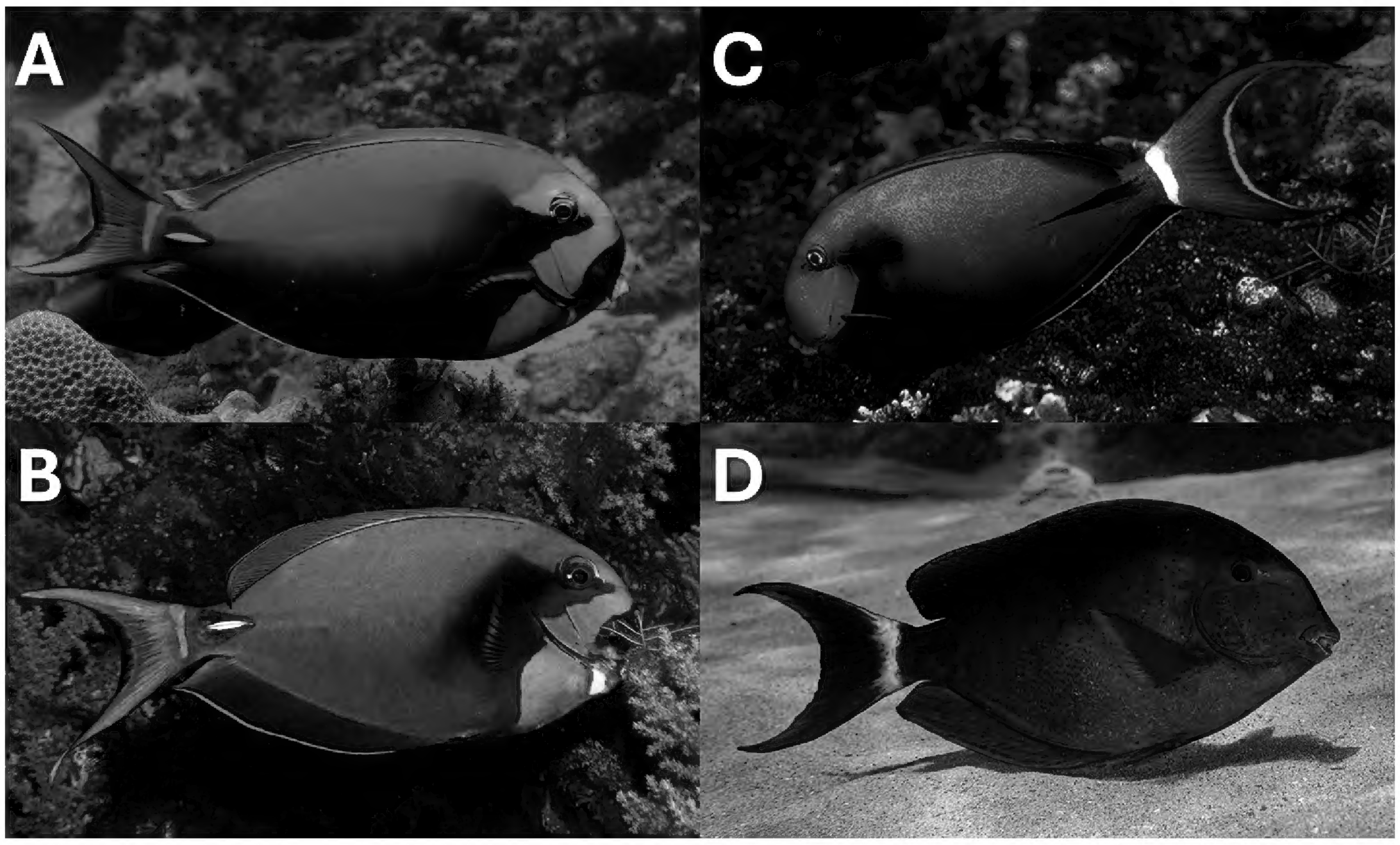

Figure 7. A, B. *Acanthurus leucocheilus* side-view of adult, photos by C. Howe at Komodo, Indonesia and G. Allen at Raja Ampat, Indonesia respectively. **C.** *Acanthurus nigricauda* side-view of adult, photo by G. Allen at Bali, Indonesia. **D.** *Acanthurus xanthopterus* side-view of dark colour morph adult, photo by C. and A. Estapé at Isla de Coiba, Panamá.

leucocheilus does not. The former's caudal spine is black, whereas the latter's is white. Another defining characteristic of *A. leucocheilus* is its red lips surrounded by a white outline, which give the species its common name: Pale-lipped Surgeonfish (Randall 1956, 1987; Kuiter and Tonozuka 2001).

Acanthurus leucocheilus might also be confused with the Yellow-fin Surgeonfish, *A. xanthopterus* Valenciennes, 1835, which is found in the waters of the Galápagos Archipelago. Though typically distinct in appearance, *A. xanthopterus* has a darker colour morph (Figure 7D) that more closely resembles *A. leucocheilus*. Both species have a yellow outer third of their pectoral fin and a white band across the base of the caudal fin. However, *A. xanthopterus* can be identified via a prominent yellow patch extending forward from the eye and a black line marking the caudal spine, whereas *A. leucocheilus* has a white-marked caudal spine (Randall 1956; Robertson and Allen 2024).

Distribution. *Acanthurus leucocheilus* is widely distributed in the Indo-Pacific. Its distribution ranges from eastern South Africa and Socotra in the Indian Ocean, to the Line Islands in the Central Pacific. It extends north to the Philippines and south to northern Australia (Figure 6) (Fricke et al. 2025; GBIF.org 2025; OBIS 2025).

Acanthurus olivaceus **Bloch & Schneider, 1801**

Figures 8, 9

New photographic record. ECUADOR — GALÁPAGOS • Marchena, Islote Espejo; 00.309°N, 090.403°W; 6 m depth; 10.II.2024; W. Bensted-Smith obs.; 1 individual photographed.

Identification. *Acanthurus olivaceus* stands out as a visually unique species in a family where morphological characteristics often overlap. It is a medium-sized surgeonfish, reaching 35 cm TL, characterised by a bright orange horizontal marking bordered by a black band, extending along the body from behind the eye. Adults of this species also feature a black mark around the caudal spine and a white patch on the centro-posterior region of the caudal fin. They can also be identified by the abrupt colour transition between the grey anterior and near-black posterior sections of their body (Figure 10A) (Randall 1956; Kuiter and Tonozuka 2001).

Figure 8. *Acanthurus olivaceus* at Marchena's Islote Espejo on 2024-2-10, photo by W. Bensted-Smith.

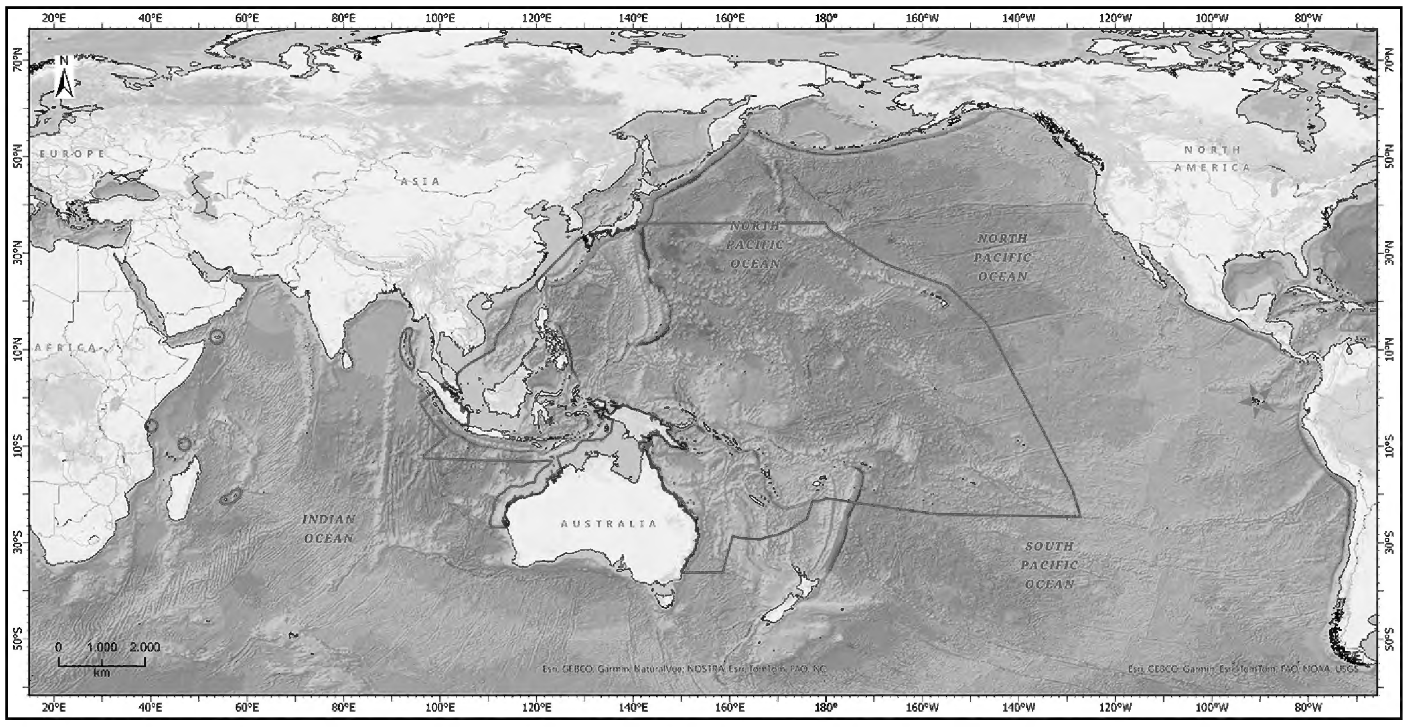

Figure 9. Previous recorded distribution (red) of *Acanthurus olivaceus* and the new photographic records (yellow star). Map created by Johny Mazón (CDF).

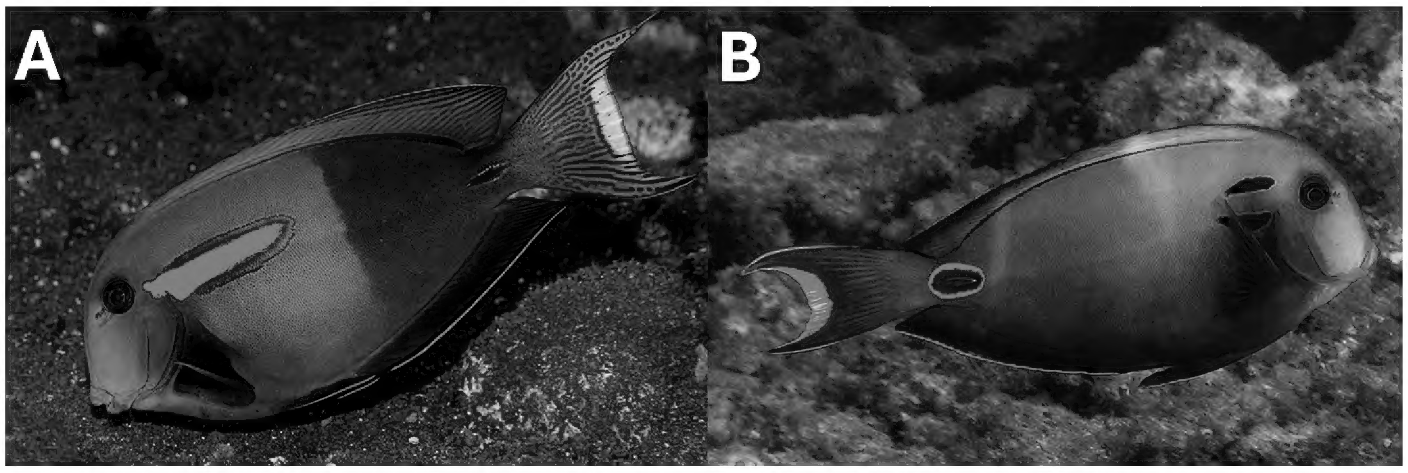

Figure 10. A. *Acanthurus olivaceus* side-view of adult, photo by G. Allen at Bali, Indonesia. **B.** *Acanthurus tennentii* side-view of adult, photo by F. Libert at Saint-Paul, La Réunion.

Acanthurus olivaceus is believed to be closely related to *A. tennentii* Günther, 1861 (Figure 10B), which occurs in the Indian Ocean. Both species share a near identical body outline and ray count, making them difficult to tell apart in preserved specimens. According to Randall (1956), the only distinguishing features lie in their body colouration. After *A. tennentii* grows past 12 cm it develops a horseshoe-shaped black mark behind the eye, which splits and turns into two curved bands. Additionally, it has a larger marking around the caudal spine.

Distribution. *Acanthurus olivaceus* is widespread in the Indo-Pacific. In the Indian ocean this species' range extends west to La Réunion, the Aldabra Atoll and Socotra Archipelago. In the Pacific it ranges west to the Line Islands in the CTP, Japan and Hawai'i in the North, and Australia in the South (Figure 9) (Fricke et al. 2025; GBIF.org 2025; OBIS 2025).

***Naso hexacanthus* (Bleeker, 1855)**
Figures 11, 12

New photographic records. ECUADOR — Galápagos • Floreana, Corona del Diablo; 01.216°S, 090.423°W; 10 m depth; 15.V.2024; Cindy Manning obs.; 1 individual photographed • Floreana, Enderby; 01.233°S, 090.360°W; 10 m depth; 3.VI.2024; C. Estapé and A. Morgan-Estapé obs.; 3 individuals photographed • Seymour, Mosquera; 00.407°S, 090.276°W; 10 m depth; 5.VI.2024; C. Estapé and A. Morgan-Estapé obs.; 2 individuals photographed.

New survey record. ECUADOR — Galápagos • Floreana, Champion; 01.239°S, 090.423°W; 6 m depth; 24.V.2001; F. Rivera obs.; 6 individuals observed.

Identification. *Naso hexacanthus* is a hornless unicornfish (Randall 1994) that can grow to 75 cm TL. It is commonly found swimming above coral and rocky reefs between depths of 10 and 40 m, but it has been found at depths of up to 164 m. During the juvenile and subadult phases, these fish are typically uniformly blue-grey to brown (Figure 13A). However, as adults they tend to develop a vertical colour gradient, transitioning from blue-grey or brown on the upper body to yellowish brown on the lower half (Figure 13B). Meanwhile, the anal and pelvic fins are yellow-olive; the dorsal fin olive; and the pectoral and caudal fins are blue-grey. The rear margins of the operculum and preopercle are typically dark, forming a distinctive dark-edged halfmoon on the cheek. During courtship, males might develop a blue hue on the upper head and front of the body, along with blue lines and spots on the front flank (Randall 2001; Robertson and Allen 2024).

Naso vlamingii (Valenciennes, 1835) is the most similar of the three other unicornfish species recorded

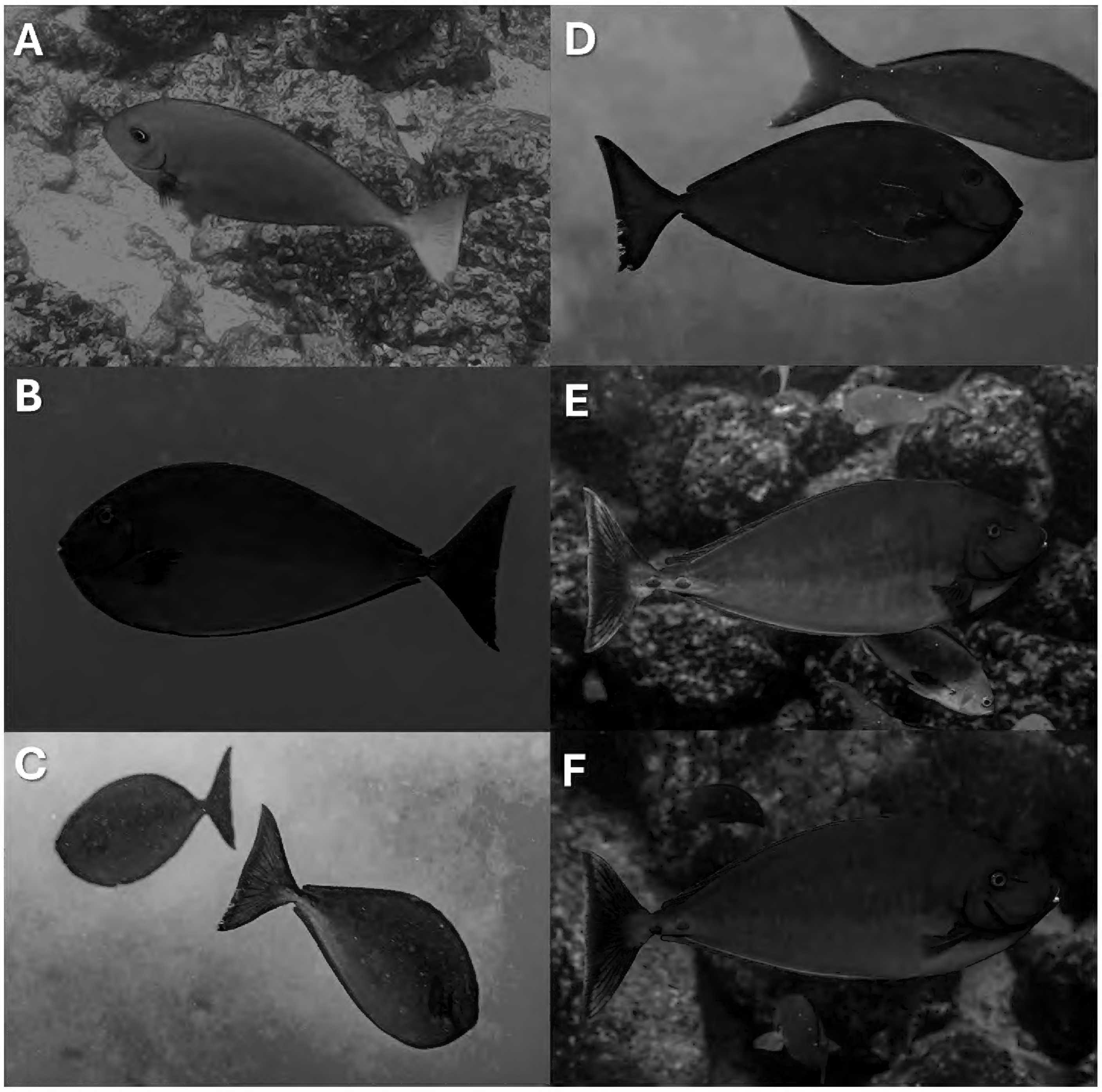

Figure 11. *Naso hexacanthus*. **A.** Subadult at Floreana's Corona del Diablo on 2024-5-15, photo by C. Manning. **B, C, D.** Subadults at Enderby Islet on 2024-6-3, photos by C. and A. Estapé. **E, F.** Adults at Mosquera on 2024-6-5, photos by C. and A. Estapé.

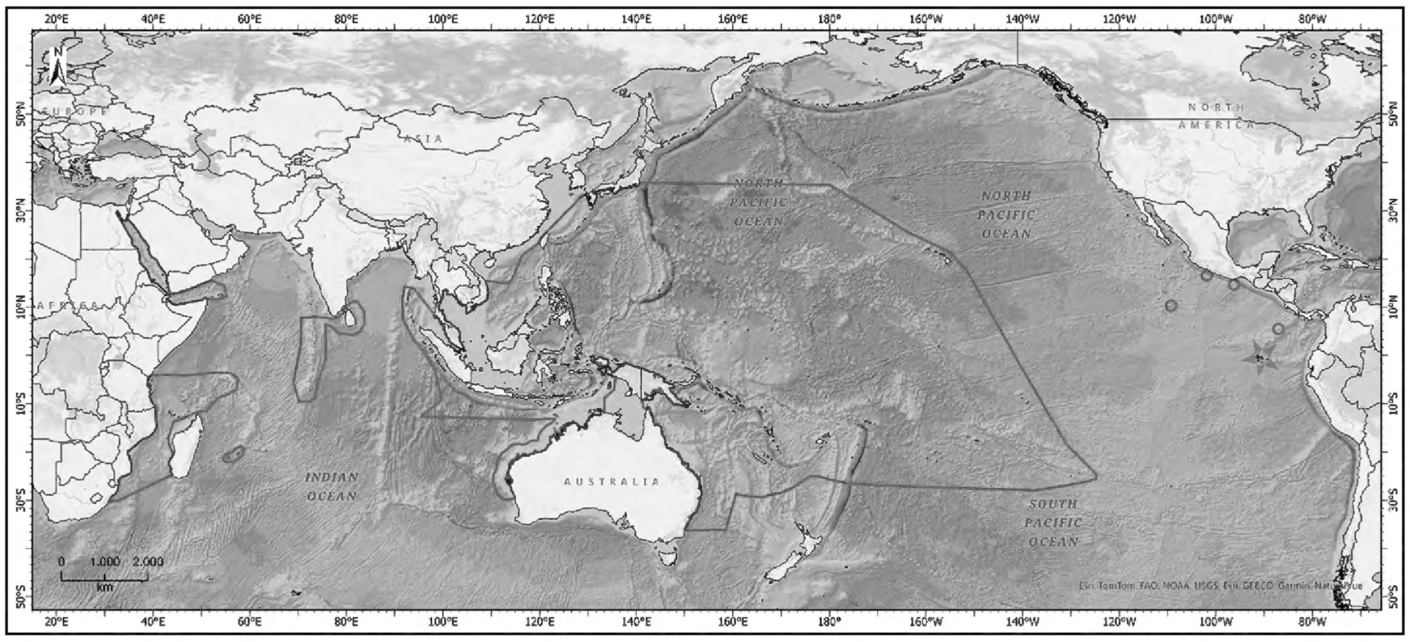

Figure 12. Previous recorded distribution (red) of *Naso hexacanthus* and the new photographic records (yellow star). Map created by Johny Mazón (CDF).

as vagrants in the GMR. It belongs to the round-type group of *Naso* and lacks a horn-shaped protuberance (Arai and Sato 2007). Unlike *N. hexacanthus*, *N. vlamingii*'s lips are blue, whereas the former's are white. The dorsal and anal fins colours also differ, with *N. vlamingii*'s having yellow-brown fins with thin blue margins. The caudal fin transitions from blue at the base to brown in the centre and yellow at the rear margin. Whereas on *N. hexacanthus*, the base of the caudal fin matches the body colouration, followed by a blue main section and a broad olive margin (Figure 13D). As juveniles and subadults both fish exhibit uniform body colourations and relatively small humps before the eyes, but *N. vlamingii* retains its blue markings on the head and body (Figure 13C) (Randall 2001; Robertson and Allen 2024).

During its subadult phase, *N. hexacanthus* also shares similarities with *N. caeruleacauda* Randall, 1994 (Figure 13E, F), and both species are often seen schooling together. They have similar grey body colours which transition into a blue caudal fin. However, *N. caeruleacauda* lacks the olive margin at the rear of the caudal fin and does not have dark margins on the opercle and preopercle. A key defining feature separating these two species is the number of bony plates with keel-like blades on each side of the caudal peduncle.

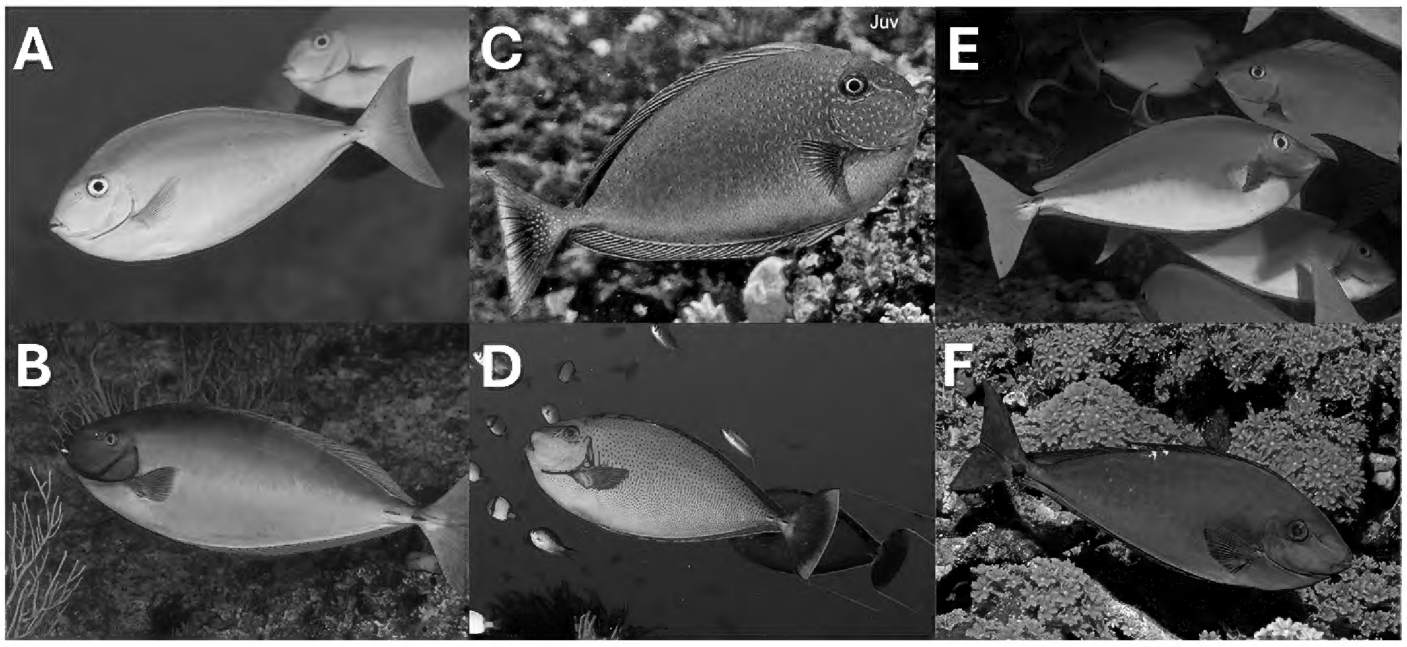

Figure 13. A, B. *Naso hexacanthus*. **A.** Side-view of subadult, photo by D. Rolla at O'ahu, Hawai'i. **B.** Side-view of adult, photo by D. Rolla at Ra, Fiji. **C, D.** *Naso vlamingii*. **C.** Side-view of juvenile, photo by R. Robertson at Monterey Bay Aquarium, California. **D.** Side-view of adult, photo by M. Rosenstein at Lovukol, Solomon Islands. **E, F.** *Naso caeruleacauda*. **E.** Light colour morph side-view, photo by J. Greenfield at Raja Ampat, Indonesia. **F.** Dark colour morph side-view, photo by K. Clements at Kimbe Bay, Papua New Guinea.

Most *Naso* species, including *N. hexacanthus*, have two, but *N. caeruleacauda* belongs to a small group that has only one (Randall 1994).

Distribution. The range of *Naso hexacanthus* is extensive, stretching from South Africa and the Red Sea to the Line Islands. Within the Pacific it extends North to Japan and Hawai'i, and south to Australia. It also occasionally appears as a vagrant at the ETP offshore islands of Clipperton and Isla del Coco, as well as the Pacific coast of Mexico (Figure 12) (Robertson and Allen 2024; Fricke et al. 2025; GBIF.org 2025; OBIS 2025).

Chaetodon punctatofasciatus **Cuvier, 1831**
Figures 14, 15

New photographic record. ECUADOR — GALÁPAGOS • Pinta, East Pinta; 00.626°N, 090.755°W; 15 m depth; 09.II.2024; F. Terán obs.; 2 individuals photographed.

Identification. *Chaetodon punctatofasciatus*, commonly known as the Spotband butterflyfish, is a species that can reach 12 cm TL and is often observed in pairs. It is typically associated with coral reefs down to depths of 45 m (Allen et al. 1998). Within its species complex, there are two species with which it is known to hybridise in the wild: *C. guttatissimus* and *C. pelewensis*. Meanwhile, *C. multicinctus* is a Hawaiian endemic which does not biogeographically overlap with the other species, though heterospecific pairings have been observed under laboratory conditions (McMillan et al. 1999; Montanari 2018).

Despite sharing similar body colourations, these species each exhibit specific patterns which are consistent across large geographic areas. *Chaetodon punctatofasciatus* is characterised by a reduced orange-yellow vertical eye band with a dark edge, which, during the juvenile phase, is connected to a black horseshoe-shaped mark on the forehead. As the fish matures, this marking becomes disconnected. Its body is predominantly yellow with 7–8 dark vertical bars dorsally, which fade to a white ventral region with rows of dark spots (Figure 16A, B). *Chaetodon pelewensis* closely resembles *C. punctatofasciatus* but can be distinguished by the orientation of its vertical bars, which angle diagonally from the rear of the dorsal fin towards the pectoral fin.

A shared feature among all three species is the caudal fin pattern: a transparent posterior edge followed by a black band and then a white or cream band. However, they diverge in the colouration of the caudal

Figure 14. *Chaetodon punctatofasciatus* at Pinta East on 2024-2-9, photo by F. Terán.

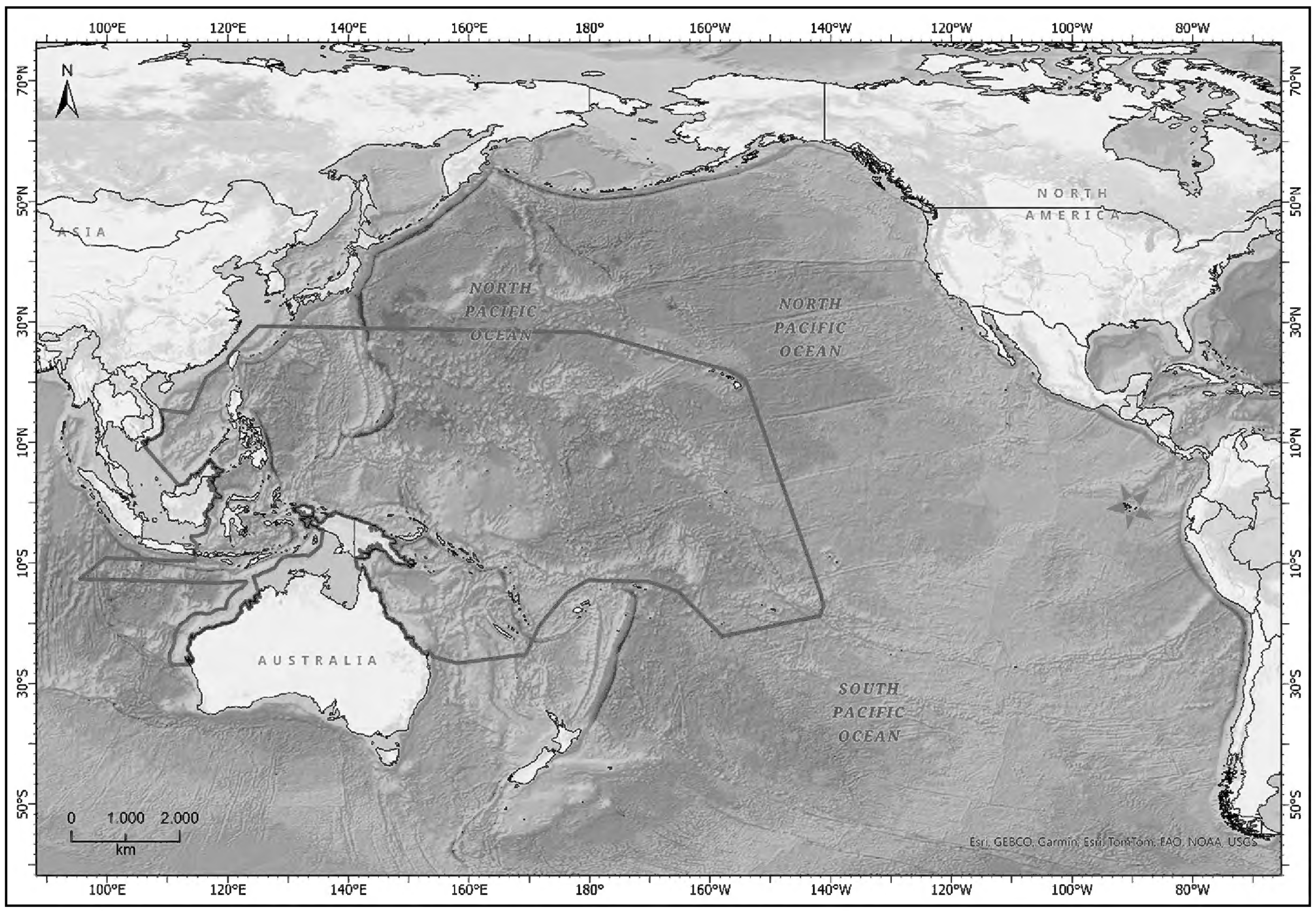

Figure 15. Previous recorded distribution (red) of *Chaetodon punctatofasciatus* and the new photographic records (yellow star). Map created by Johny Mazón (CDF).

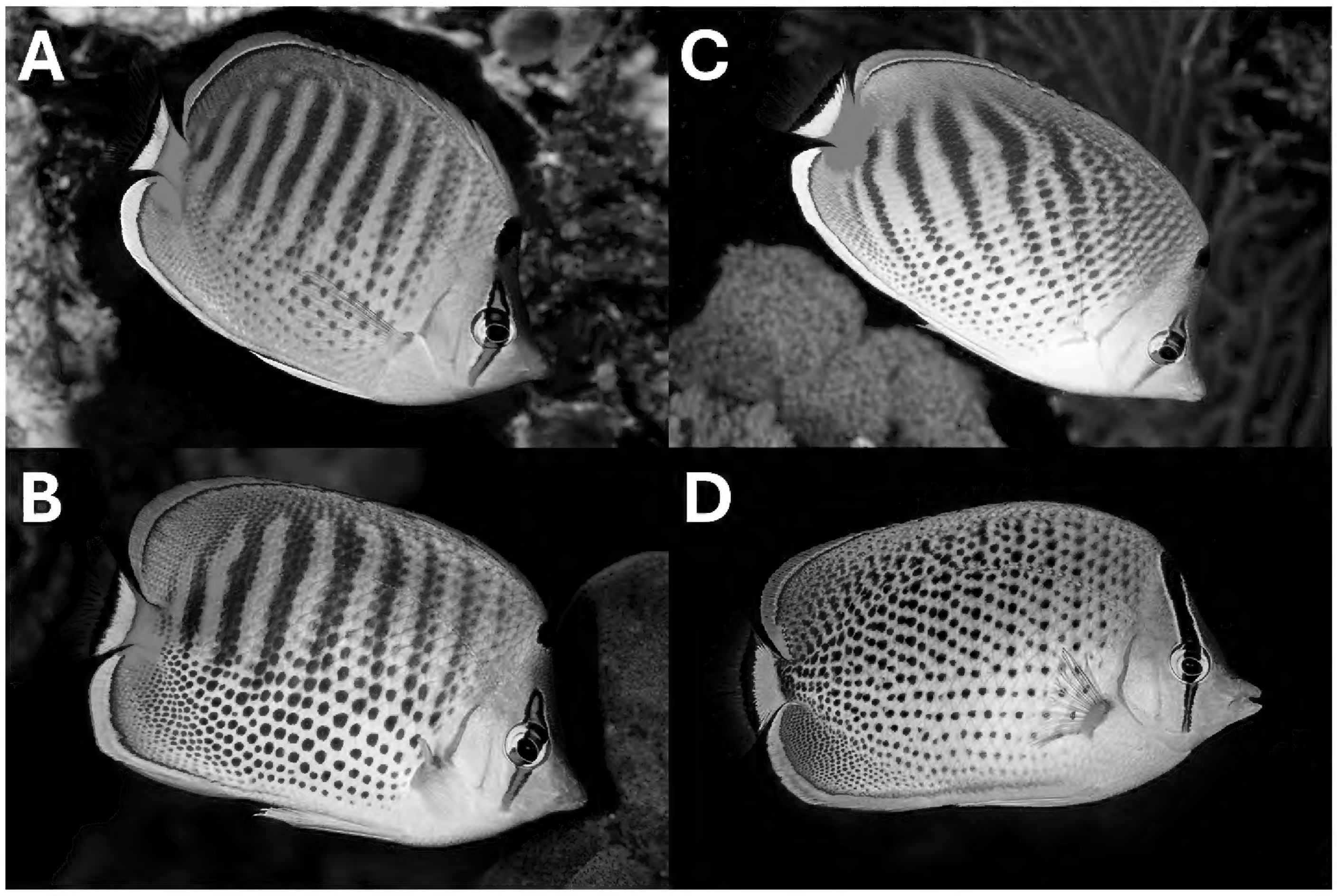

Figure 16. A, B. *Chaetodon punctatofasciatus*. **A.** Side-view of juvenile, photo by G. Allen at Timor-Leste. **B.** Side-view of adult, photo by W. Osborn at Pulau Tomia, Indonesia. **C.** *Chaetodon pelewensis* side-view of adult, photo by M. Rosenstein at Ra, Fiji. **D.** *Chaetodon guttatissimus* side-view of adult, photo by F. Libert at Saint-Leu, La Réunion.

peduncle, which is orange on *C. punctatofasciatus* and *C. pelewensis*, while *C. guttatissimus* has a dusky bar (Figure 16C). *Chaetodon guttatissimus* also differs by having a longer and darker eye band, which extends to the top of the forehead. It also has a body covered in weakly arranged horizontal and vertical rows of dark spots (one per scale) including on the dorsal and anal fins (Figure 16D) (Burgess 1978; Randall et al. 1997).

Hybridisation between these species can blur their morphological differences, making identification challenging (Littlewood et al. 2004). These hybrids normally occur in areas where the species' geographic ranges overlap, sometimes resulting in near homogenous colour patterns (McMillan et al. 1999; Montanari 2018). However, hybrids of this complex have not been observed in the Galápagos Islands.

Distribution. *Chaetodon punctatofasciatus* has a smaller distribution than the other Indo-Pacific fishes in this paper. In the Pacific this species ranges from the Line Islands in the CTP, north to Hawai'i and Japan, south to Australia, and west to Malaysia. In the eastern Indian Ocean, it is found along western Australia, Malaysia, Cocos Keeling Islands, and Christmas Island (Australia) (Figure15) (Fricke et al. 2025; GBIF.org 2025; OBIS 2025).

Kyphosus sectatrix **(Linnaeus, 1758)**
Figures 17, 18

New photographic records. ECUADOR — GALÁPAGOS • Darwin, Darwin's Arch; 01.673°N, 091.990°W; 12 m depth; 12.X.2021; W. Bensted-Smith obs.; 1 individual photographed • Floreana, Corona del Diablo; 01.216°S, 090.423°W; 12 m depth; 14.I.2024; W. Bensted-Smith obs.; 1 individual photographed • Darwin, Darwin's Arch; 01.673°N, 091.990°W; 18 m depth; 06.II.2024; W. Bensted-Smith obs.; 1 individual photographed • Marchena, Roca Espejo; 00.313°N, 090.401°W; 15 m depth; 10.II.2024; W. Bensted-Smith obs.; 3 individuals photographed.

Identification. *Kyphosus sectatrix* is a relatively large chub, capable of reaching 76 cm TL and diving to depths of 93 m (Robertson and Allen 2024). The genus *Kyphosus* is known for the similarities between its species, sometimes making underwater identification difficult. Within the GMR, two similar species of the genus had already been recorded: *K. elegans* (Peters, 1869), Cortez Sea Chub, and *K. vaigiensis* (Quoy & Gaimard, 1825), Blue-bronze Chub.

Both *K. sectatrix* and *K. vaigiensis* have gently sloping foreheads from above the eye to the snout, giving the head a slanted appearance (Figure 19C, E). In contrast, *K. elegans* has a more abrupt slope, giving the head a blunt shape with a bump before the eye (Figure 19A). All three species have silvery bodies, but *K. vaigiensis* has 23–29 golden to brassy horizontal lines on each flank (Figure 19F), which may appear as a uniform silver or dark-grey flank depending on the angle of the light. *Kyphosus sectatrix* also sometimes exhibits weak horizontal lines, and all three species may have partially golden scales spread across the body.

Figure 17. *Kyphosus sectatrix*. **A.** Xanthic adult at Darwin's Arch on 2021-10-22, photo by W. Bensted-Smith. **B.** Adult at Floreana's Corona del Diablo on 2024-1-14, photo by W. Bensted-Smith. **C.** Xanthic adult at Darwin's Arch on 2024-2-6, photo by W. Bensted-Smith. **D, E.** Adults at Marchena's Roca Espejo on 2024-2-10, photos by W. Bensted-Smith.

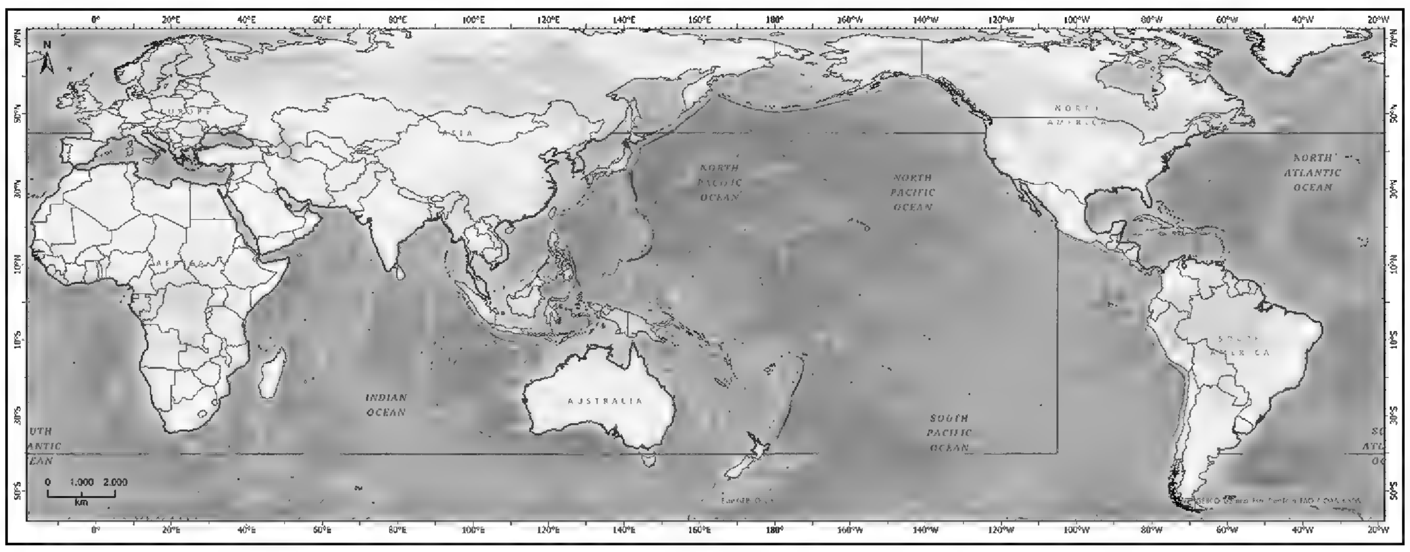

Figure 18. Previous recorded distribution (red) of *Kyphosus sectatrix* and the new photographic records (yellow star). Map created by Johny Mazón (CDF).

Additionally, both *K. sectatrix* and *K. vaigiensis* have a streak under the eye, but these differ in colour: white on the *K. sectatrix* (Figure 19C) and gold on *K. vaigiensis* (Figure 19E). Each species also has a unique anal fin: low on *K. vaigiensis* (Figure 19F), relatively long on *K. elegans* (Figure 19B), and moderately elevated on *K. sectatrix* (Figure 19D). Juveniles of these species may also develop eye-sized white or pale spots on their bodies (Randall 2007; Knudsen and Clements 2013; Robertson and Allen 2024).

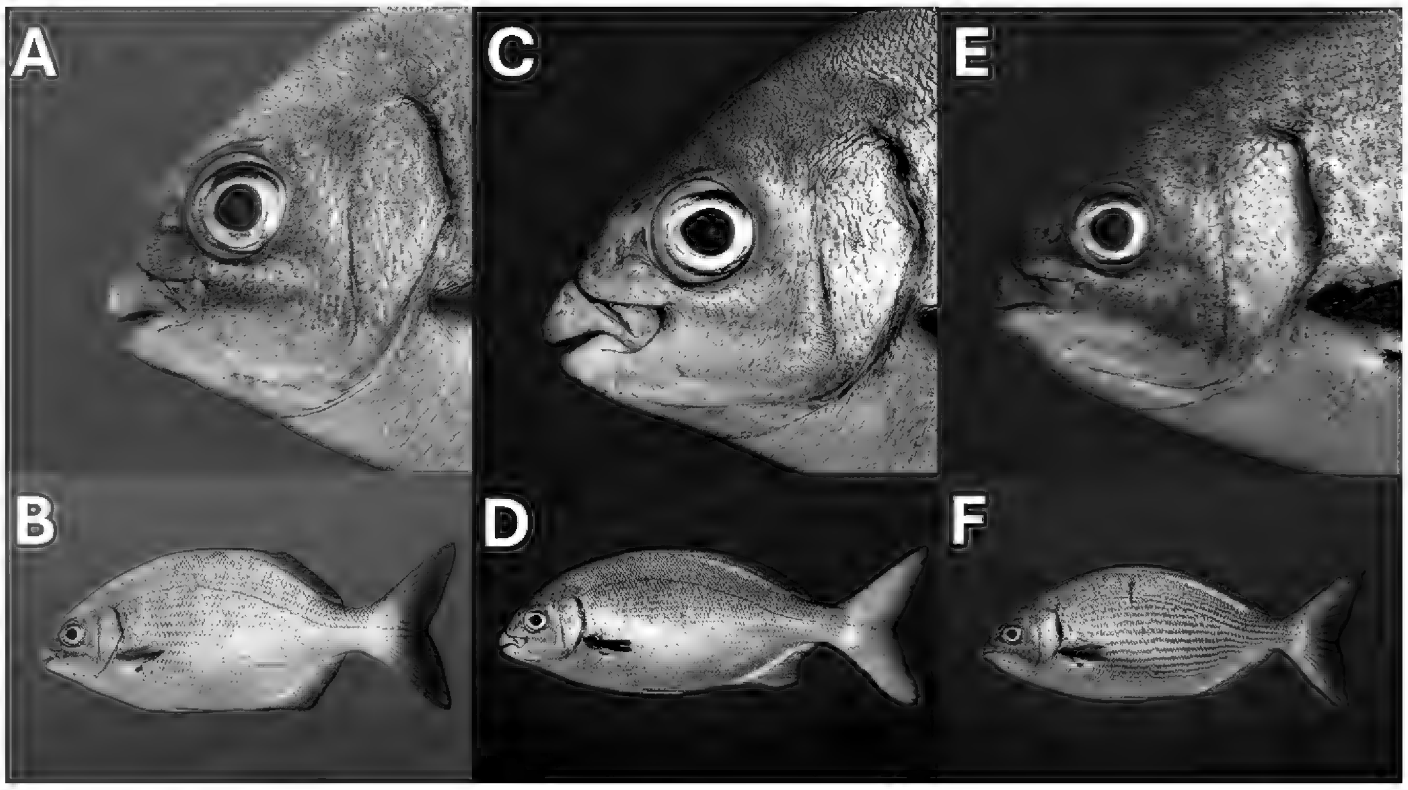

Figure 19. A, B. *Kyphosus elegans* at Baja California, Mexico. **A.** Close-up of head. **B.** Side-view. **C, D.** *Kyphosus sectatrix* at Archipiélago de Revillagigedo, Mexico. **C.** Close-up of head. **D.** Side-view. **E, F.** *Kyphosus vaigiensis* at Galápagos Islands, Ecuador. **E.** Close-up of head. **F.** Side-view. All photos by C. and A. Estapé.

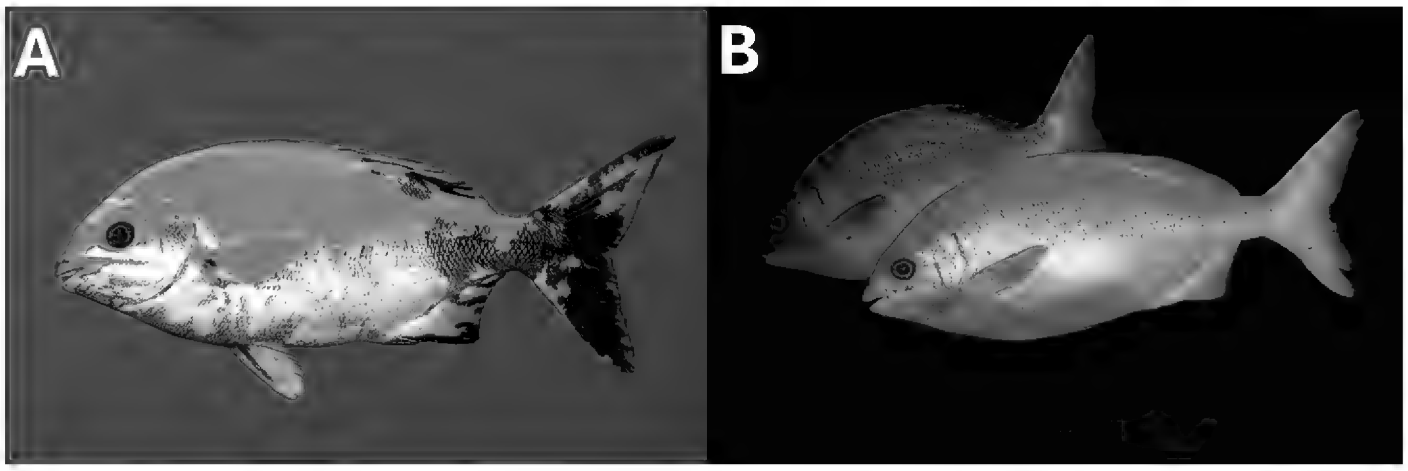

Figure 20. A, B. *Kyphosus sectatrix* xanthic forms side-view, photos by C. and A. Estapé at Archipiélago de Revillagigedo, Mexico.

Kyphosus sectatrix is also known to occasionally have a xanthic form, which can manifest in several colour variations: an entirely yellow body; blotches of black; yellow and white (Figure 20); or, in rare cases, completely white. This xanthic form occurs more frequently at isolated oceanic islands.

Distribution. *Kyphosus sectatrix* is a circumglobal species. Its most northern occurrence was 44.6°N in France, whilst its most southern observation was 37.5°S in New Zealand. Within the ETP this species is only established in Archipiélago de Revillagigedo, Clipperton, and southern Baja California (Figure 18) (Robertson and Allen 2024; Fricke et al. 2025; GBIF.org 2025).

Gymnothorax porphyreus (Guichenot, 1848)
Figures 21, 22

New photographic record. ECUADOR — Galápagos • Fernandina, Cabo Douglas; 01.239°S, 090.384°W; 14 m depth; 11.V.2024; W. Bensted-Smith, F. Krasovec, and C. Cox obs.; 1 individual photographed.

Identification. *Gymnothorax porphyreus* is a yellowish to grey-brown moray eel with a relatively short snout, which grows to 130 cm TL. It typically inhabits shallow rocky reefs at depths of up to 13 m. The head and body are densely covered in irregular, pupil-sized dark spots, sometimes giving the eel an overall brown appearance. Its nostrils are dark and the pores on its head are white with fine dark margins (Figure 23A). Ad-

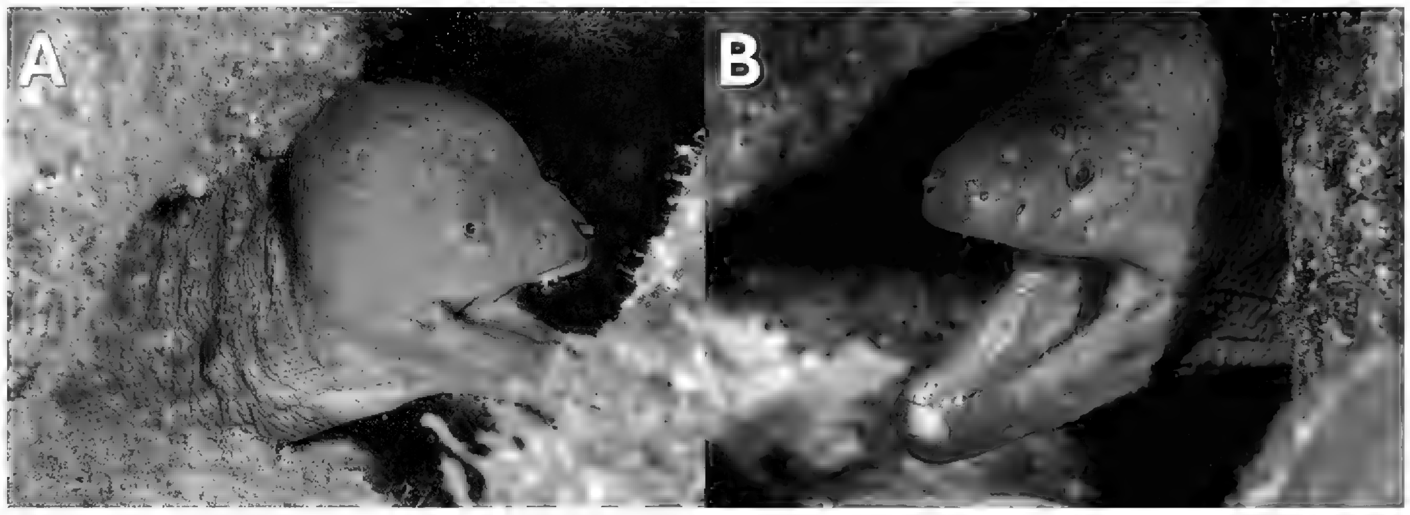

Figure 21. A, B. *Gymnothorax porphyreus* at Fernandina's Cabo Douglas on 2024-5-11, photos by C. Cox and F. Krasovec respectively.

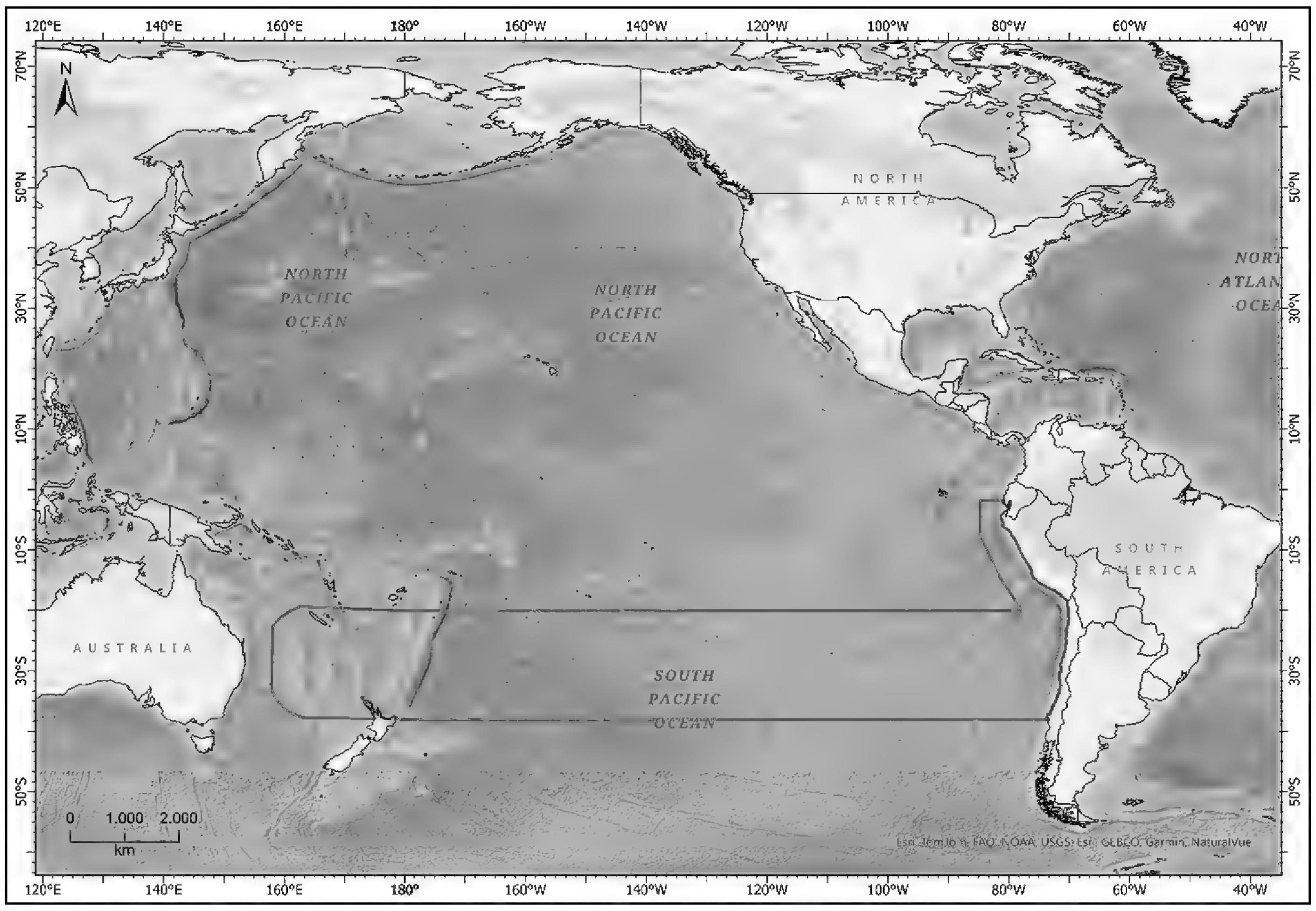

Figure 22. Previous recorded distribution (red) of *Gymnothorax porphyreus* and the new photographic records (yellow star). Map created by Johny Mazón (CDF).

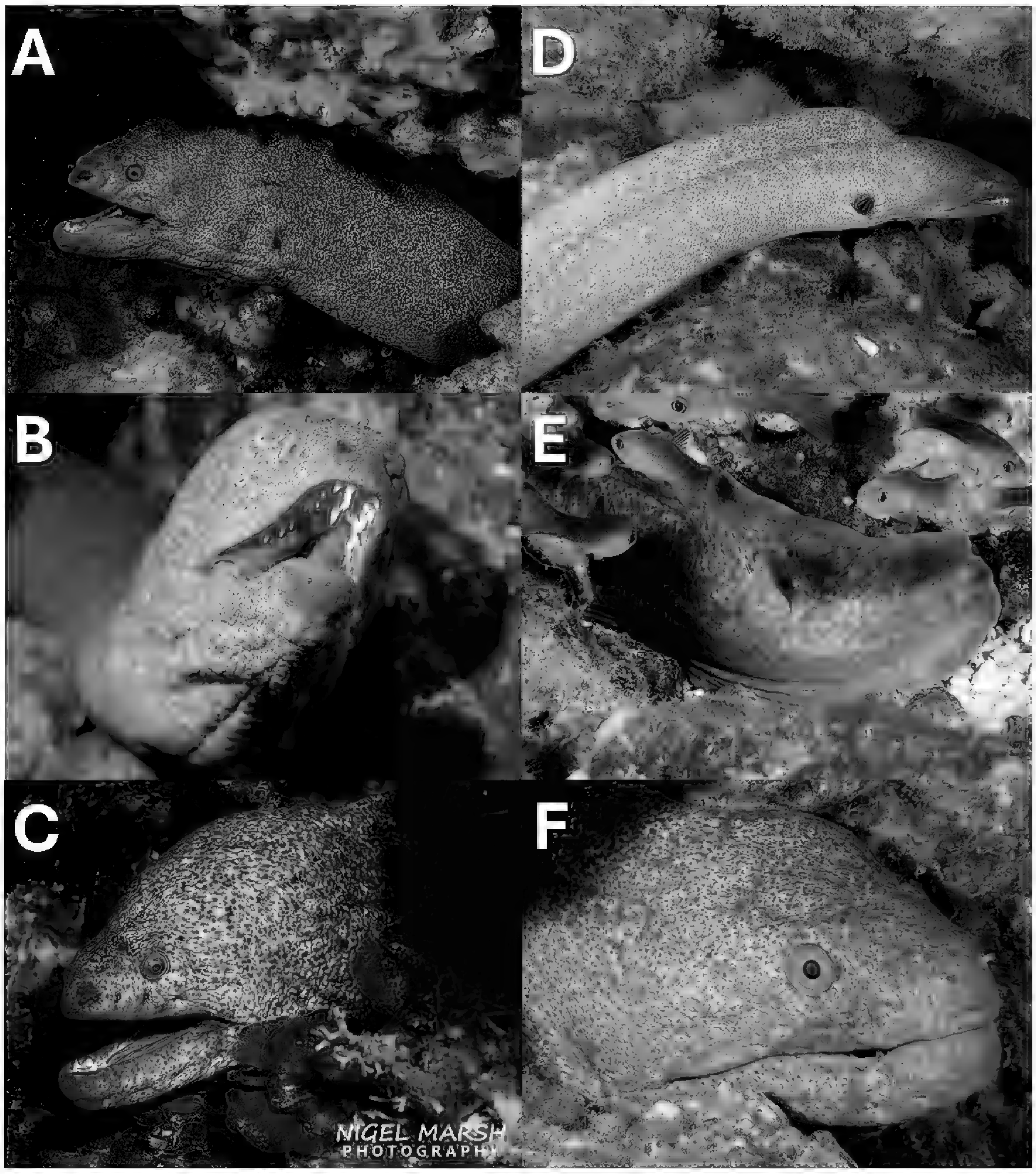

Figure 23. A, B, C. *Gymnothorax porphyreus*. **A.** Side-view, photo by S. Spindler at Aorangi, New Zealand. **B.** Close-up of mouth, photo by D. Ó Súilleabháin at Tawhiti Rahi, New Zealand. **C.** Close-up of head, photo by N. Marsh at Tawhiti Rahi, New Zealand. **D, E, F.** *Gymnothorax flavimarginatus*. **D.** Side-view. **E.** Close-up of tail. **F.** Close-up of head, photos by W. Bensted-Smith at Isla del Coco, Costa Rica.

ditionally, the interior of the mouth may have a yellow-orange hue, which appears to be more pronounced in younger individuals (Figure 23B). Commonly known as Lowfin Moray, this species is distinguished by its relatively low dorsal fin, which begins just before the gill opening (Randall and McCosker 1975; Böhlke and McCosker 2001; Robertson and Allen 2024).

Gymnothorax flavimarginatus (Rüppell, 1830) is a species that shares several morphological traits with *G. porphyreus* and is occasionally observed in the Galápagos. Both have yellowish bodies covered in dark-brown spots but can be differentiated by the colour of the blotch on the gill opening. On *G. flavimarginatus* the gill blotch is distinctly black, whereas, on *G. porphyreus* it is dark but not black (Figure 23A, D). Another distinctive feature is the eye colour: *G. flavimarginatus* has a bright yellow-orange iris, whilst *G. porphyreus*' has a dull yellow-brown iris (Figure 23C, F). If the back half of the moray is visible, *G. flavimarginatus* can be identified by its distinctive yellow-green margins to the posterior fins (Figure 23E). On the other hand, juvenile *G. porphyreus* have a white fin margin, while adults have no distinctive margin (Böhlke and McCosker 2001; Robertson and Allen 2024).

Distribution. *Gymnothorax porphyreus* typically inhabits the colder waters of the South Pacific. This species ranges from New Caledonia in the west to the Pacific coast of South America in the east. It was previously only known to reach as far north as southern Ecuador in the East Pacific (Robertson and Allen 2024; Fricke et al. 2025; GBIF.org 2025; OBIS 2025).

Halichoeres malpelo **Allen & Robertson, 1992**
Figures 24, 25

New photographic records. ECUADOR — Galápagos • Darwin, Wellington Reef; 01.678°N, 091.997°W; 16 m depth; 02.IV.2023; W. Bensted-Smith obs.; 8 individuals photographed • Seymour North, Fishbowl; 00.398°S, 090.280°W; 10 m depth; 03.XII.2023; W. Bensted-Smith obs.; 2 individuals photographed.

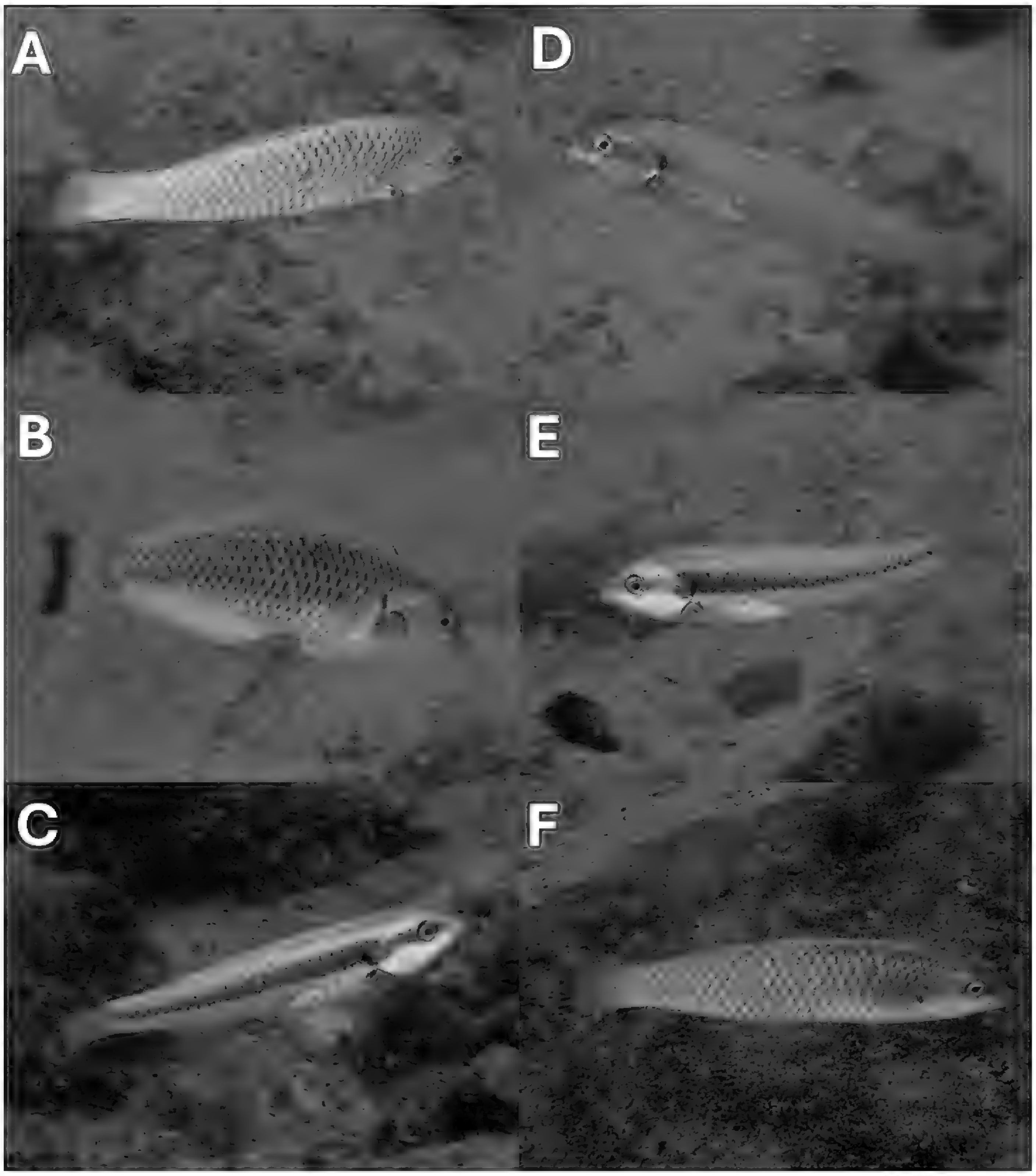

Figure 24. *Halichoeres malpelo*. **A, B.** Terminal phase fish at Darwin's Wellington Reef on 2023-4-2, photos by W. Bensted-Smith. **C, D, E.** Initial phase fish at Darwin's Wellington Reef on 2023-4-2, photos by W. Bensted-Smith. **F.** Terminal phase fish at Seymour's Fishbowl on 2023-12-3, photo by W. Bensted-Smith.

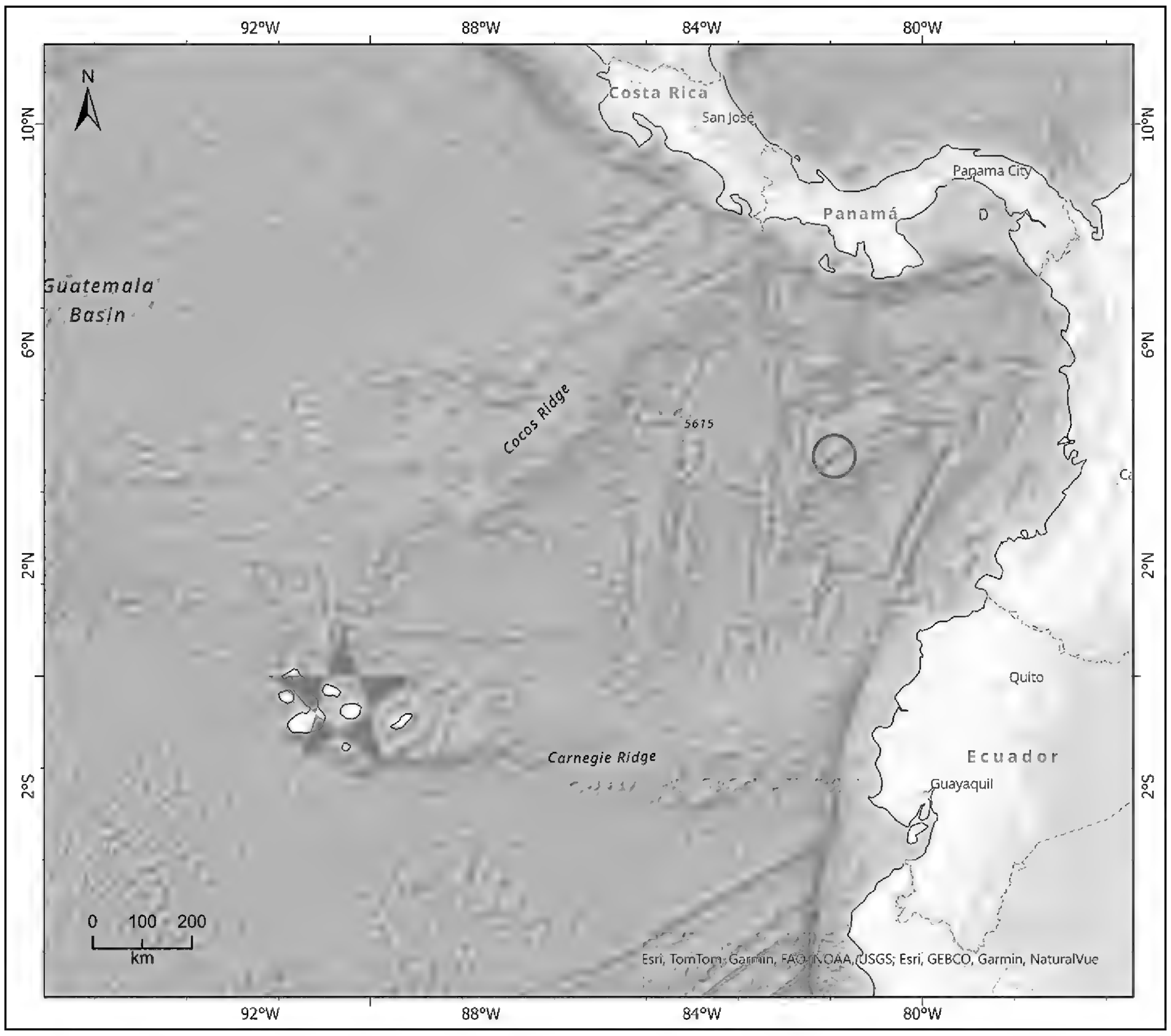

Figure 25. Previous recorded distribution (red) of *Halichoeres malpelo* and the new photographic records (yellow star). Map created by Johny Mazón (CDF).

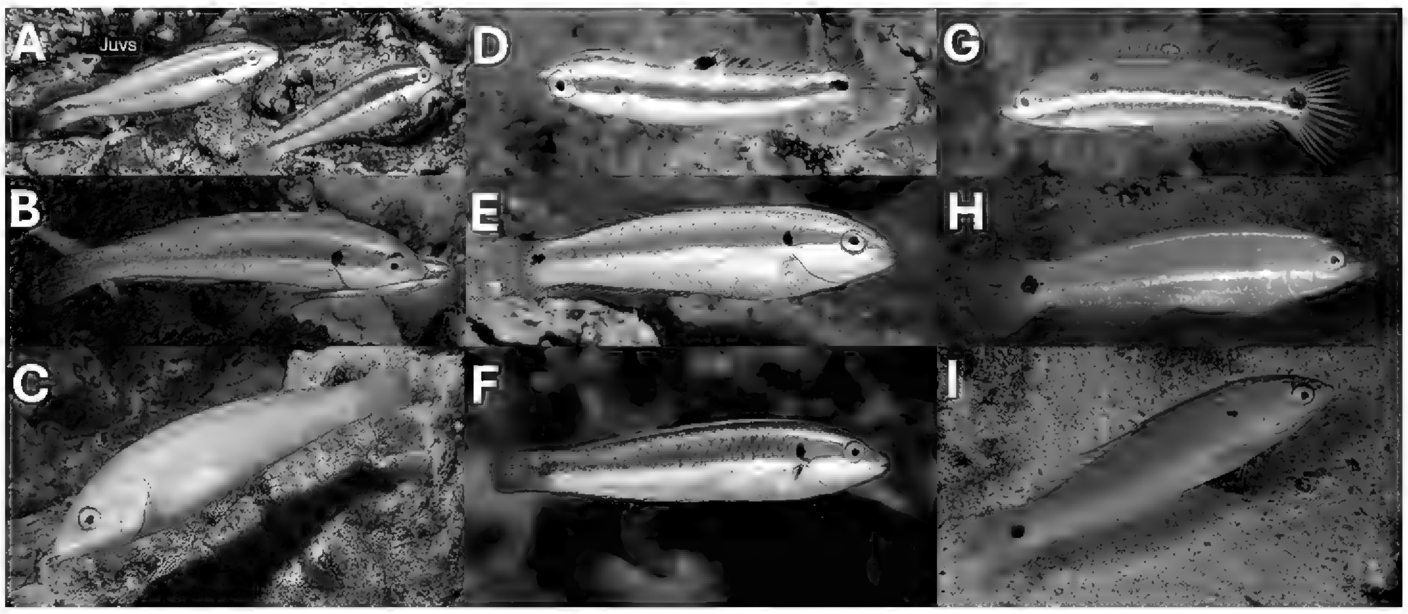

Figure 26. A–C. *Halichoeres malpelo* at Isla de Malpelo, Colombia. **A.** Juveniles, photo by R. Robertson. **B.** Young initial phase, photo by G. Edgar. **C.** Adult initial phase, photo by R. Robertson. **D–F.** *Halichoeres salmofasciatus* at Isla del Coco, Costa Rica. **D.** Juvenile, photo by W. Bensted-Smith. **E, F.** Initial phase, photos by C. and A. Estapé. **G–I.** *Halichoeres dispilus*, photos by W. Bensted-Smith at Galápagos Islands, Ecuador. **G.** Juvenile. **H.** Young initial phase. **I.** Adult initial phase.

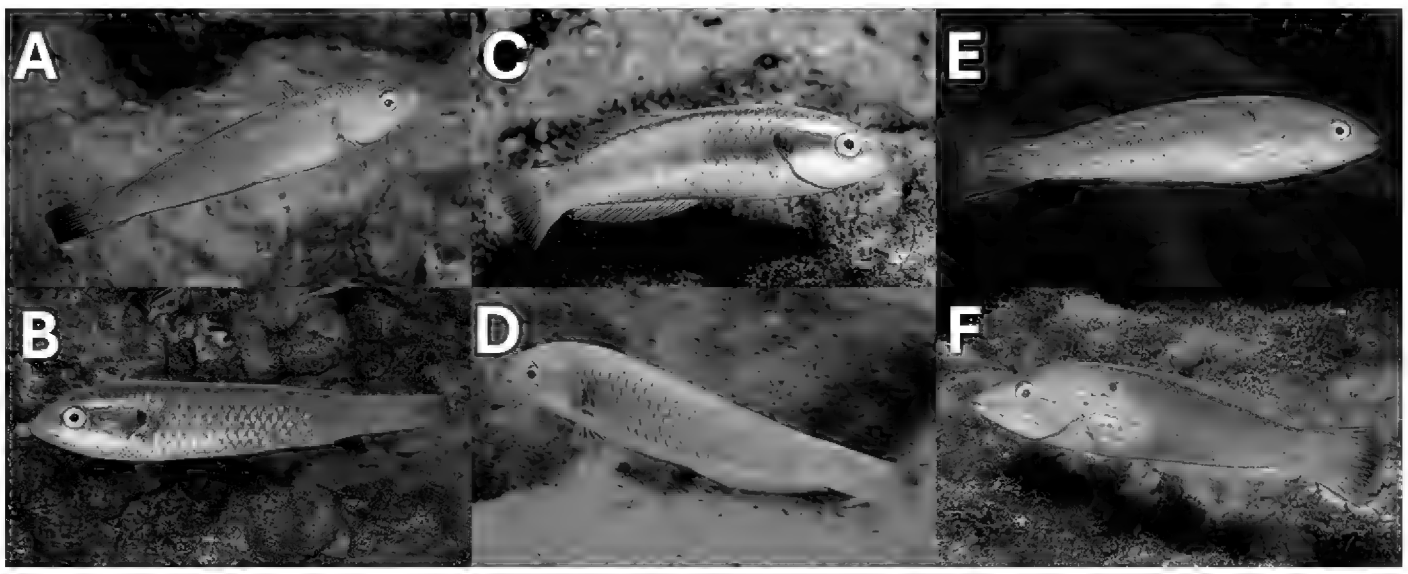

Figure 27. A, B. *Halichoeres malpelo* terminal phase, photos by G. Edgar and I. Keith respectively at Isla de Malpelo, Colombia. **C, D.** *Halichoeres salmofasciatus* terminal phase, photos by C. and A. Estapé and W. Bensted-Smith respectively at Isla del Coco, Costa Rica. **E, F.** *Halichoeres dispilus* terminal phase, photos by W. Bensted-Smith at Isla del Coco, Costa Rica and Galápagos Islands, Ecuador respectively.

Identification. *Halichoeres malpelo* is a slim, benthic wrasse which can grow to 18 cm TL and inhabits rocky or soft-bottom habitats between depths of 10 and 20 m. As with most wrasses, this species has both an initial phase (IP) and a terminal phase (TP). During the IP, individuals are mostly pinkish white, with a yellow

head and operculum, and a white patch on the underside (Figure 26C). However, photographic evidence indicates that younger individuals may display horizontal red stripes running from the head to the base of the caudal fin—one along the mid-dorsal line and another through the eye and along the flank (Figure 26A, B). This species also occasionally exhibits a black mark on its operculum (Figure 26A, B). The TP of *H. malpelo* is mostly a pale green-blue, with a pink-red iris, and a dark-grey outer third of the caudal fin (Figure 27A). Some TP members of this species have also been photographed with a black spot on the operculum (Figure 27B) (Allen and Robertson 1992; Robertson and Allen 2024).

These morphological characteristics closely resemble *H. salmofasciatus*, a species present on the nearby Isla del Coco that occupies a similar habitat. However, this species is differentiated by two prominent black spots, one on the operculum and the other at the base of the caudal fin (Figure 26D, E, F). Furthermore, *H. salmofasciatus* does not appear to have an adult IP stage with a pink body and yellow head. In its TP, *H. salmofasciatus* typically has an olive-coloured upper body, a dark stripe along the mid-flank, a dark spot on the rear of the operculum, a pink-red iris, and a dark outer third of its caudal fin (Figure 27C) (Allen and Robertson 1992, 2002; Robertson and Allen 2024). However, it sometimes may also display a uniform white-cream colour (Figure 27D). The two species also differ significantly in maximum recorded length, with *H. malpelo* reaching 18 cm, whereas *H. salmofasciatus* only grows to 12 cm (Robertson and Allen 2024).

Halichoeres dispilus (Günther, 1864) individuals were seen swimming with *H. malpelo* at Darwin's Wellington Reef. They share several similar traits when found above sandy bottoms. This species' appearance varies greatly depending on its habitat (Grove and Lavenberg 1997). Both TP and IP individuals of *H. dispilus* often have two dark spots, one above the pectoral fin and the other at the base of the caudal fin. However, they can be told apart from *H. malpelo* by the presence of blue lines on the head and caudal fin of the TP individuals (Figures 26G–I, 28E, F). The caudal fin of TP *H. dispilus* may have a dark-blue outer margin, which could be confused for the dark outer thirds of the caudal fins of *H. salmofasciatus* and *H. malpelo*. However, as shown in Figure 27, TP colouration in all three species is highly variable, so it is not always the most reliable indicator.

Juveniles of *H. dispilus* may also display red-brown and white horizontal stripes, as well as a dorsal ocellus like *H. salmofasciatus* (26D, G). Unfortunately, there is currently little to no data on juvenile *H. malpelo* (Grove and Lavenberg 1997; Allen and Robertson 2002; Robertson and Allen 2024).

Distribution. The native range of *H. malpelo* is limited to Isla de Malpelo off the Pacific coast of Colombia (Figure 25) (Robertson and Allen 2024; Fricke et al. 2025).

DISCUSSION

The Galapagos are no stranger to spontaneous vagrant arrivals and mass settlements (Humann and DeLoach 2003; Acuña-Marrero and Salinas-De-León 2013; Robertson et al. 2021; Mossbrucker et al. 2023). ENSO events are often associated with the appearance of new discovered species in ETP archipelagos. These can include Indo-Pacific species during warmer El Niño periods or South American cold-water species during La Niña (Robertson et al. 2004; Bensted-Smith et al. 2023). This publication documents four new arrivals from the CTP: *Acanthurus leucocheilus* (Figure 6), *Acanthurus olivaceus* (Figure 9), *Naso hexacanthus* (Figure 12), and *Chaetodon punctatofasciatus* (Figure 15). It also identifies one pantropical species: *Kyphosus sectatrix* (Figure 18) and three from within the ETP: *Ctenochaetus marginatus* (Figure 3), *Halichoeres malpelo* (Figure 25) and *Gymnothorax porphyreus* (Figure 22).

During El Niño, the South Equatorial Current (SEC) weakens or reverses and Kelvin waves depress the thermocline, leading to warmer temperatures across the GMR (Glynn 1988). These changes, combined with a strengthened North Equatorial Counter Current, may reduce fish larvae transport across the EPB to a minimum of 60 days. However, such pulses do not necessarily indicate species' migrations or range expansions, as the local abundance is often temporary (Richmond 1990; Grigg and Hey 1992; Robertson et al. 2004; Romero-Torres et al. 2018). The variability of species arrivals from the CTP may be linked to timing with spawning events, allowing different larvae to be transported across the EPB.

During La Niña, the Humboldt Current strengthens, increasing offshore transport from Perú (Schwing et al. 2002). This could have contributed to *Gymnothorax porphyreus*' arrival at Cabo Douglas, similar to the arrival of *Azurina intercrusma* (Evermann & Radcliffe, 1917) during the previous event (Bensted-Smith et al. 2023). La Niña may also prevent tropical species from establishing long-term populations. This has been seen before with the large settlements of species and their subsequent disappearance in the following years (Victor et al. 2001; Keith et al. 2024).

Additionally, larvae of many continental-shelf shorefish species not native to the archipelago were collected in plankton nets over the hydrothermal vents of the Galápagos Rift (Victor 2024). This suggests that the presence of shorefish species in Galápagos is regulated by the suitability of inshore habitats and/or ocean conditions for larvae, juvenile, or adult stages, rather than the ability of species to colonise as larvae.

During the 2023–24 ENSO event, the SEC temporarily reversed between May and June 2023, and the NECC strengthened from August 2023 to January 2024 (CMEMS 2024). These circulation changes may have

contributed to the arrival of new species in the Galápagos. For example, several *Chaetodon kleinii* Bloch, 1790 were observed in the Galápagos for the first time in 19 years (Keith et al. 2024). Chaetodons have shorter pelagic larval durations (PLDs) than their acanthurid counterparts, typically only lasting a maximum of 40 days (Leis 1989; Soeparno et al. 2012). This raises the question of how they might make the 60-day crossing.

Acanthurids are known for having long PLDs (Brothers and Thresher 1985), which could explain their prevalence amongst Galápagos vagrants from the CTP. However, some studies suggest larval swimming speed, behaviour, habitat detection, and delayed settlement may also have an impact (Leis and McCormick 2002; Alzate and Onstein 2022). Additionally, Atlantic *Acanthurus* larvae have previously crossed oceanic boundaries, further supporting their potential for long-distance dispersal (Rocha et al. 2002).

It is possible that some of the species recorded here arrived during previous ENSO events, such as the one in 2015/16, but evaded detection, becoming more visible on the reef due to the favourable conditions of the latest event. This has been observed amongst native tropical fishes whose populations increased during previous El Niño phenomena (Keith et al. 2024). This hypothesis could be applied to *A. leucocheilus*, *A. olivaceous*, and *N. hexacanthus*. They were all found in areas with relatively uniform habitat extending hundreds of metres to kilometres along the coastline. *Naso hexacanthus* is known to have a home range of up to 5 km, and several *Acanthurus* species are known to range up to 3 km (Green et al. 2015). These species may also have evaded detection due to insufficient survey efforts.

However, the sheltered Coral Garden at Wolf, where *Chaetodon kleinii* and *Ctenochaetus marginatus* were observed, is limited in size and frequently surveyed by the CDRS dive team over multiple days, several times a year. Between 2016 and 2024, the team completed 13 expeditions at the site. Furthermore, members of these two genera typically have home ranges smaller than 300 m, making it unlikely that they would venture far on the reef (Green et al. 2015). Both species were observed and conspicuous at the site on every dive from February to October 2024, suggesting they likely arrived during the 2023/24 ENSO event.

Acanthurids typically grow fast within the first year of life, with some completing 90% of their growth in that time. Size of individuals of this family is therefore not seen as a good measure of their age (Choat and Axe 1996; Trip et al. 2014). A good example of this is the rapid growth of *C. marginatus* individuals at Wolf's Coral Garden (Figure 2A, B). During the first visit, only juveniles were observed along the reef but by the next visit, 3½ months later, the juveniles had been replaced by subadults and small adults (Figure 2D, E). If this change represented individual growth, it would suggest an approximate growth rate of 0.75 mm per day, which 1.7 times that of its congener *C. striatus* (Trip et al. 2014). It is worth noting that the typical adult size of *C. marginatus* is 1.5 times greater than that of *C. striatus*. The possible rapid maturation of *C. marginatus* juveniles may reflect the pressures associated with settling in a new habitat with few conspecifics, possibly driving a heightened allocation of resources toward growth and survival.

If, instead of arriving as larvae, some of the fishes mentioned herein were to have arrived as adults or subadults, they may have travelled with rafts. These could be marine debris or drifting Fish Aggregating Devices (dFADs), which could provide both shelter and food. However, surgeonfish and butterflyfish, which rely on hard-reef substrates, are unlikely to rely on rafting for dispersal, especially given the lack of structural complexity of a lot of marine debris, which many reef fish depend on (Luiz et al. 2015). With the exception of pelagic and semi-pelagic species, most fish found with rafts are juveniles and not related to either chaetodontids or acanthurids. (Hunter and Mitchell 1967; Taquet et al. 2007).

An alternative dispersal mechanism could be seaweed rafts, which Luiz et al. (2014) suggested as a possible vector for a butterflyfish off the coast of Brazil. These rafts offer more complex ecosystems, among which reef fish could survive and grow while drifting in the open ocean. This debris has been linked to the recent establishment of two fish species in the Hawaiian Islands (Benadon et al. 2024). Pumice rafts may also provide an alternative, these can form extensive floating masses which drift around oceans under the influence of currents. These long-lasting rafts are able to harbour corals, providing a viable food source for species of fish, such as *C. punctatofasciatus*, which would be otherwise unable to make the journey (Jokiel 1990; Jokiel and Cox 2003). Further studies are needed to fully assess the ichthyological fauna associated with these dispersal mechanisms.

One species which is almost certainly taking advantage of rafting opportunities is *Kyphosus sectatrix*. This species is known to spawn offshore and juveniles are often associated with floating objects, while adults are found in the bycatch of dFADs (Nemeth and Kadison 2013; Knudsen and Clements 2016; Escalle et al. 2019). The increase in artificial marine debris, with a greater longevity than its natural counterpart, over recent decades is likely increasing the connectivity of this pantropical species (Figure 18) and others of its genus, promoting their dispersal globally. This is further evidenced by the recent first appearance of *K. cinerascens* (Forsskål, 1775) in the Galápagos (C. Estapé and A. Morgan-Estapé pers. comm. 2024) and Isla del Coco (pers. obs.) in 2024, as well as the presence of *K. sectatrix* at Isla del Coco (pers. obs.).

The appearance of *Halichoeres malpelo* in the Galápagos Islands raises the question of why the species complex it belongs to has not previously colonised the area. One possibility could be the presence of an undiscovered species. However, confirmation would require collected specimens from within the GMR. The first offshore species of the complex was only described in 1992, partly due to the remoteness of these

locations and the evasive nature of these fishes. Nevertheless, unlike Isla del Coco or Revillagigedo, the Galápagos Islands have historically been extensively surveyed, with thousands of collections made and no reports of this species.

The validity of *H. salmofasciatus* and *H. malpelo* as different species is also debatable, as they share several overlapping morphological characteristics (B. Victor pers. comm. 2023). Genetic analysis is needed to confirm this, but sequences of *H. malpelo* are currently lacking. The Galápagos individuals were all between 12 and 15 cm, falling between the upper size limit of *H. salmofasciatus* and the maximum size of *H. malpelo*. Observations by the authors of the species in their native habitats showed that TP *H. salmofasciatus* are considerably smaller than those seen in the Galápagos and Malpelo.

Finally, the recent discovery of *N. hexacanthus* within the previously unpublished SEM dataset, now available on OBIS (Keith et al. 2024), highlights the importance of revisiting and publishing past visual census data that may have been overlooked. Rare observations like these are crucial for understanding the complex mechanisms that enable species to cross barriers like the EPB. The authors also believe the number of vagrant arrivals is higher than currently recognised, and as more divers use photographic equipment, more observations will be documented and, hopefully, shared on citizen science platforms like iNaturalist.

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ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

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Data availability

All data that supports the findings of this study are available in the main text.

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